

2006 ENGINE

Engine Mechanical - 4.6L (4 Of 5) - Lucerne

CRANKSHAFT REAR OIL SEAL REPLACEMENT

TOOLS REQUIRED

- **J 42841-A** Crankshaft Rear Oil Seal Remover. See **Special Tools** .
- **J 45930-A** Crankshaft Rear Oil Seal Installer. See **Special Tools** .
- **EN-48072** Sealant Applicator. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the transaxle. Refer to **Transmission Replacement** .
2. Remove the flywheel. Refer to **Engine Flywheel Replacement** .

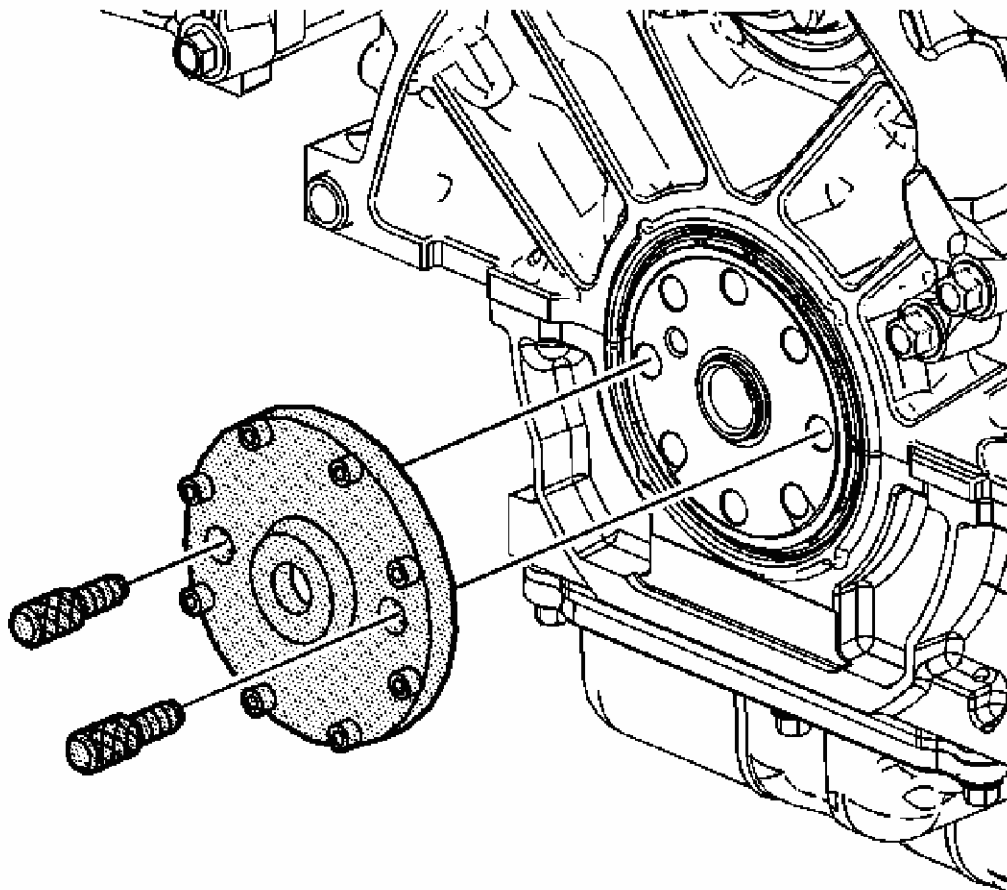


Fig. 1: View Of J 42841 Removing Rear Crankshaft Oil Seal
Courtesy of GENERAL MOTORS CORP.

3. Place the **J 42841-A** on to the crankshaft. See **Special Tools** .
4. Install the **J 42841-A** retaining bolts. See **Special Tools** .

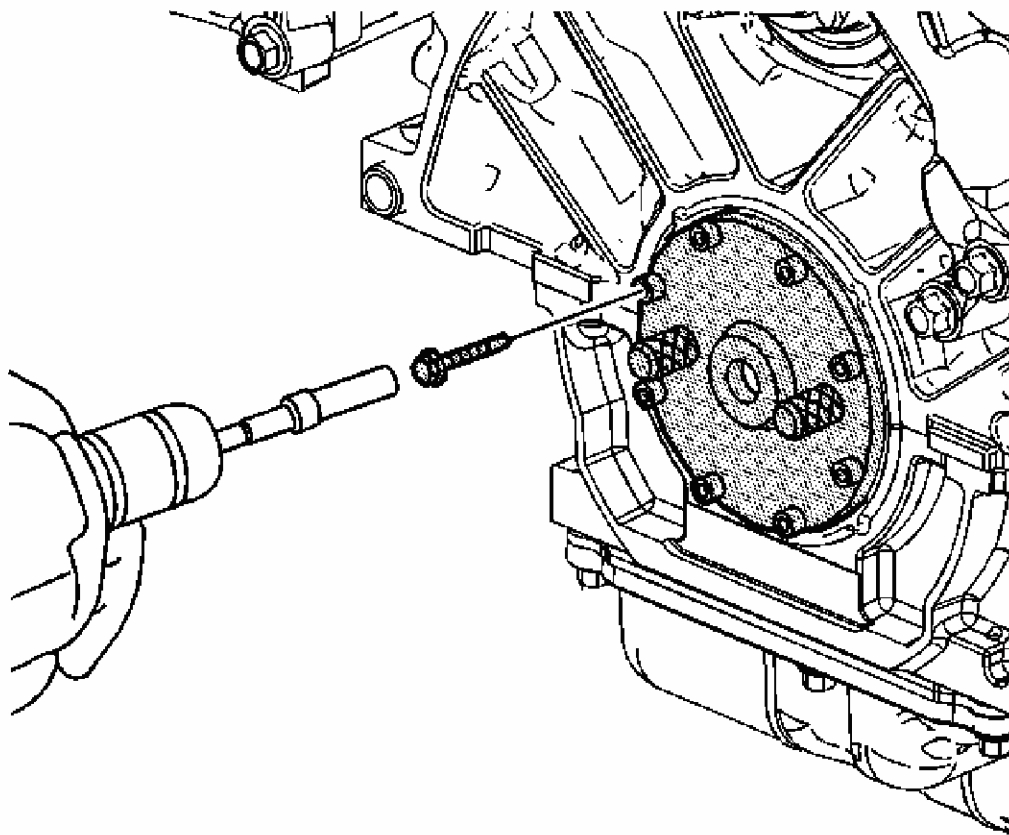


Fig. 2: Installing Screws Into Guide Holes
Courtesy of GENERAL MOTORS CORP.

5. Using a drill motor (variable speed preferred) with a socket adapter, install eight one-inch self-drilling screws into the seal using the guide holes in the removal tool. When drilling, make sure you reduce the drill speed when the screw begins threading into the seal.

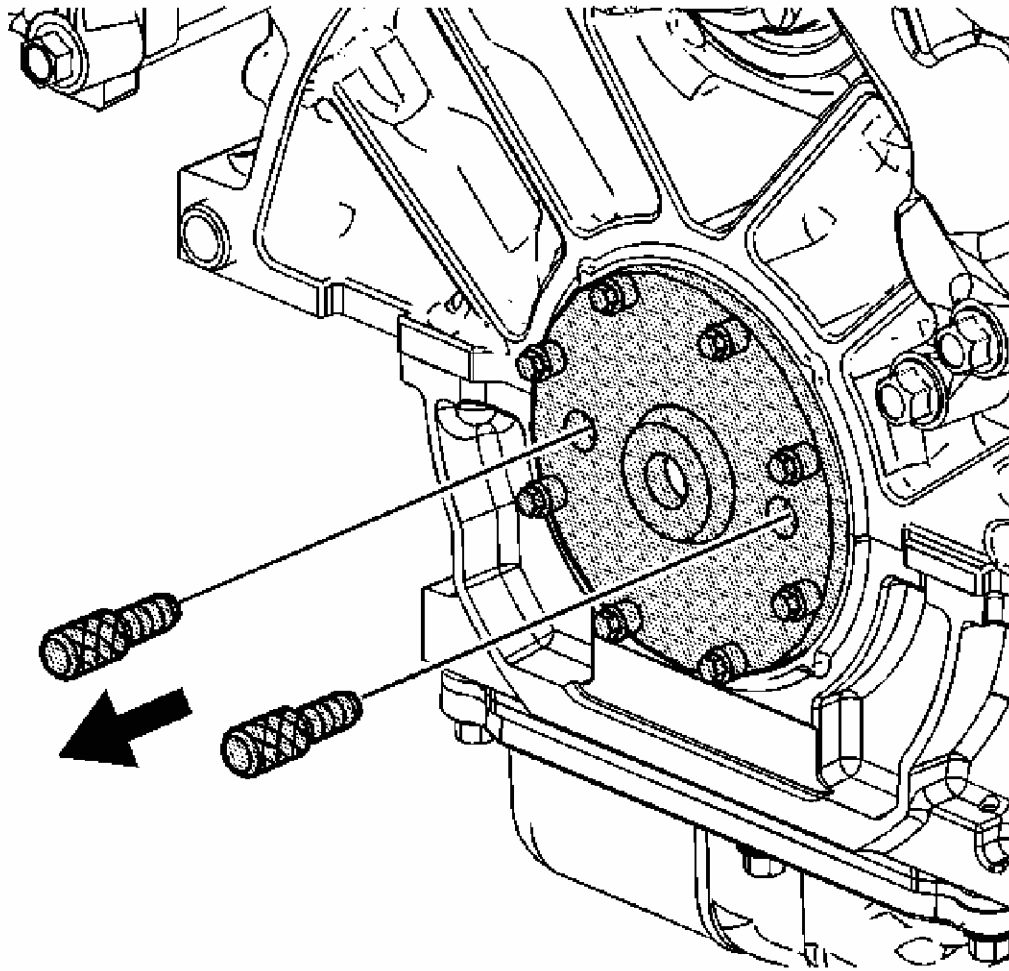


Fig. 3: View Of J 42841 & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

6. With all eight removal screws installed, remove the **J 42841-A** retaining bolts. See **Special Tools** .

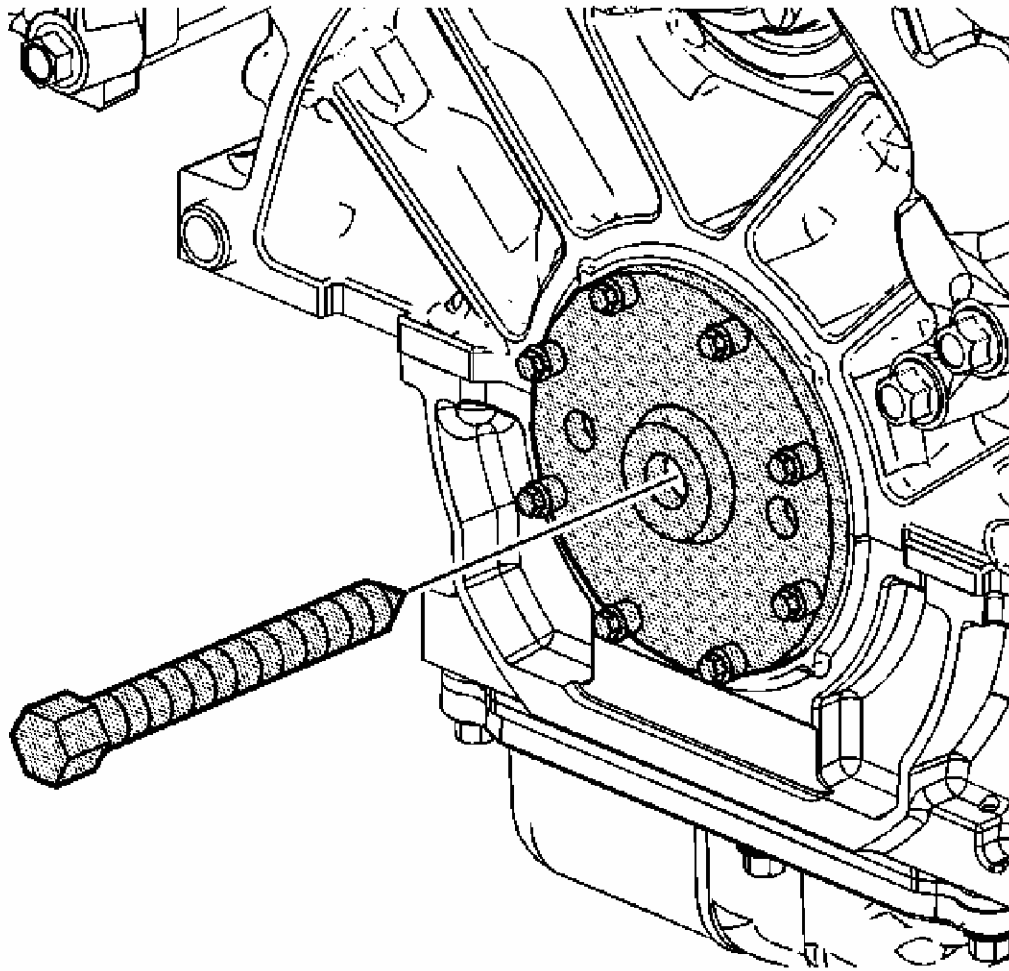


Fig. 4: View Of Center Forcing Screw
Courtesy of GENERAL MOTORS CORP.

7. Install the center screw to the **J 42841-A** . See **Special Tools** .

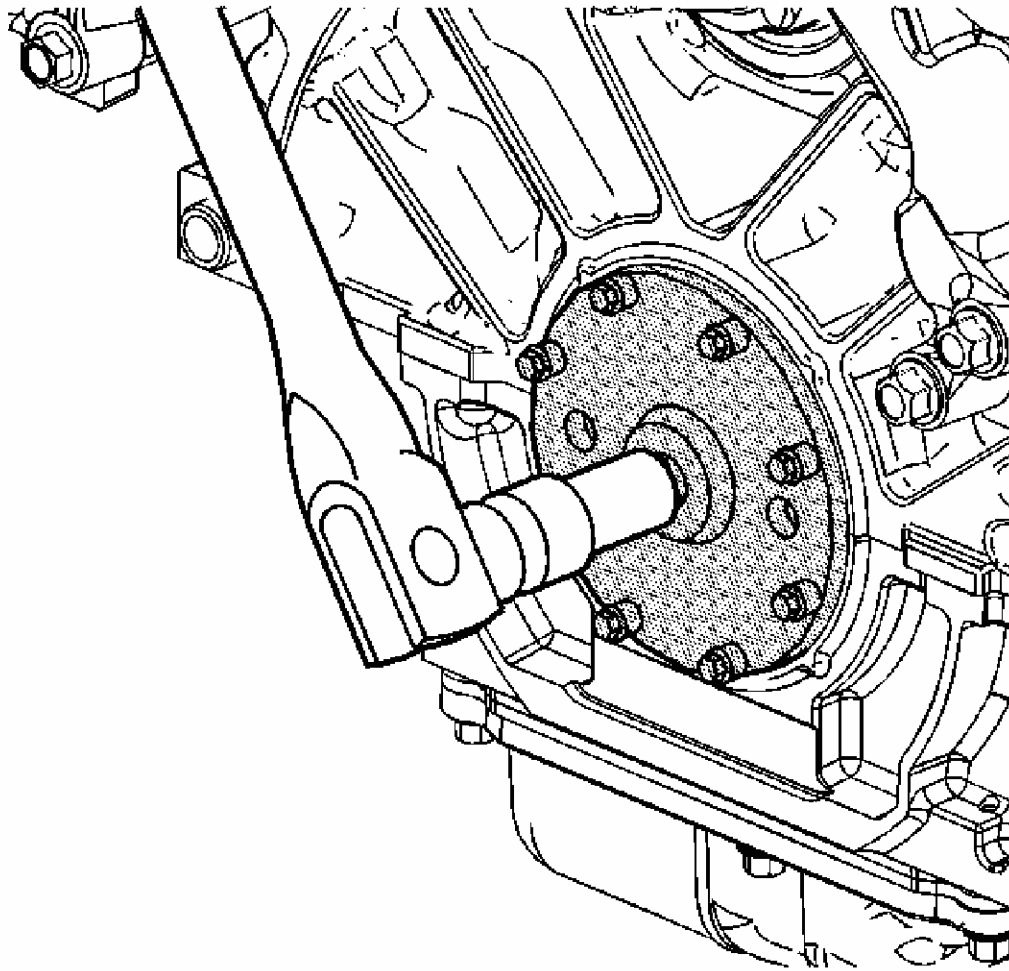


Fig. 5: View Of Center Screw On Removal Tool
Courtesy of GENERAL MOTORS CORP.

8. Tighten the center screw on the **J 42841-A** to pull the seal assembly off the end of the crankshaft. See **Special Tools** .

INSTALLATION PROCEDURE

IMPORTANT: The EN-48072 must be used to ensure even application of the sealant in the bore and to prevent blockage of the drain back hole. See **Special Tools** .

IMPORTANT: Ensure components that are being sealed with RTV sealant are assembled within 20 minutes. Components assembled

after the RTV sealant has skinned-over, approximately 20 minutes, will not bond properly.

IMPORTANT: Although originally equipped with a lip-style crankshaft rear oil seal, engines built from March 1, 1996 and thru 1999 should use the cassette-style crankshaft rear oil seal.

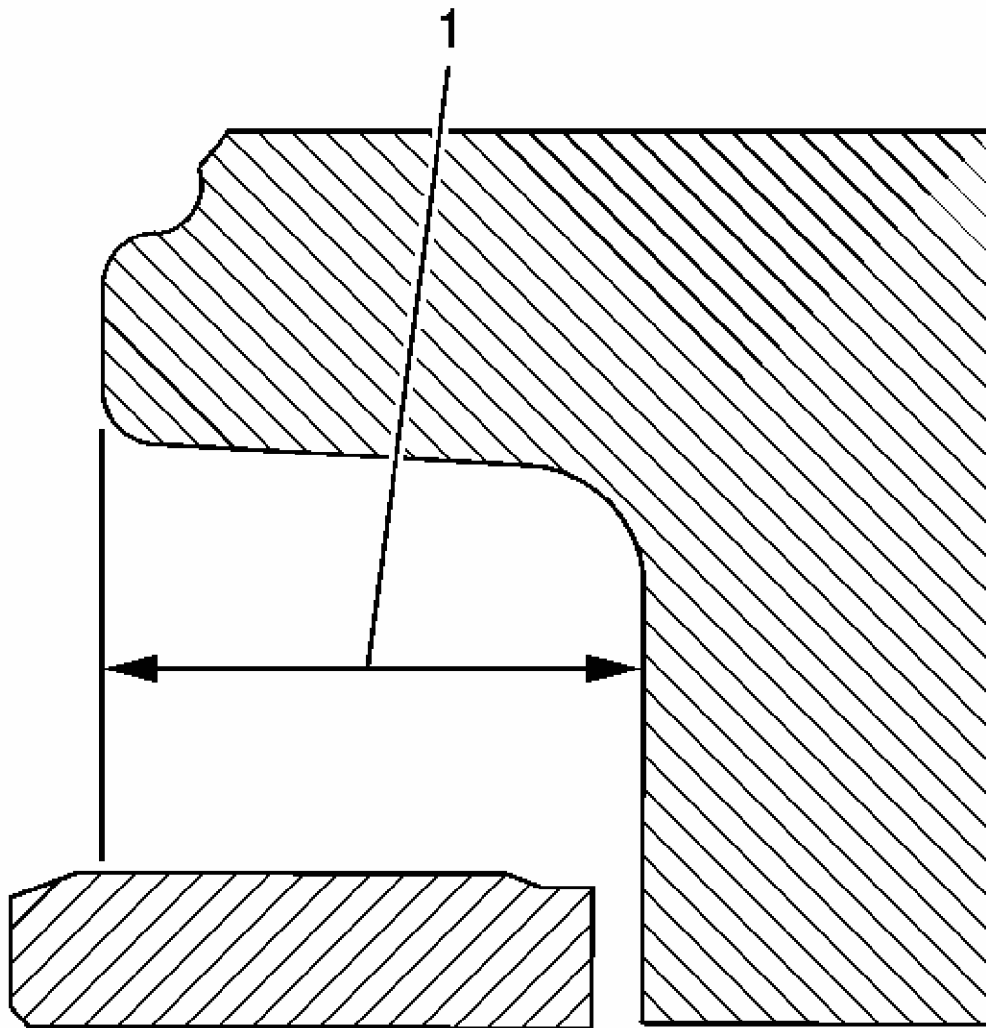


Fig. 6: Installing Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Ensure the engine block where the crankshaft rear oil seal is installed is a deep bore (1).

- A deep bore of approximately 15 mm (0.5906 in) was used on engines from March 1, 1996 and later.
- A shallow bore of approximately 8 mm (0.3150 in) was used on engines from 1993 thru February 29, 1996. This block would use a lip-style crankshaft rear oil seal and the **J 38817-A** for installation.

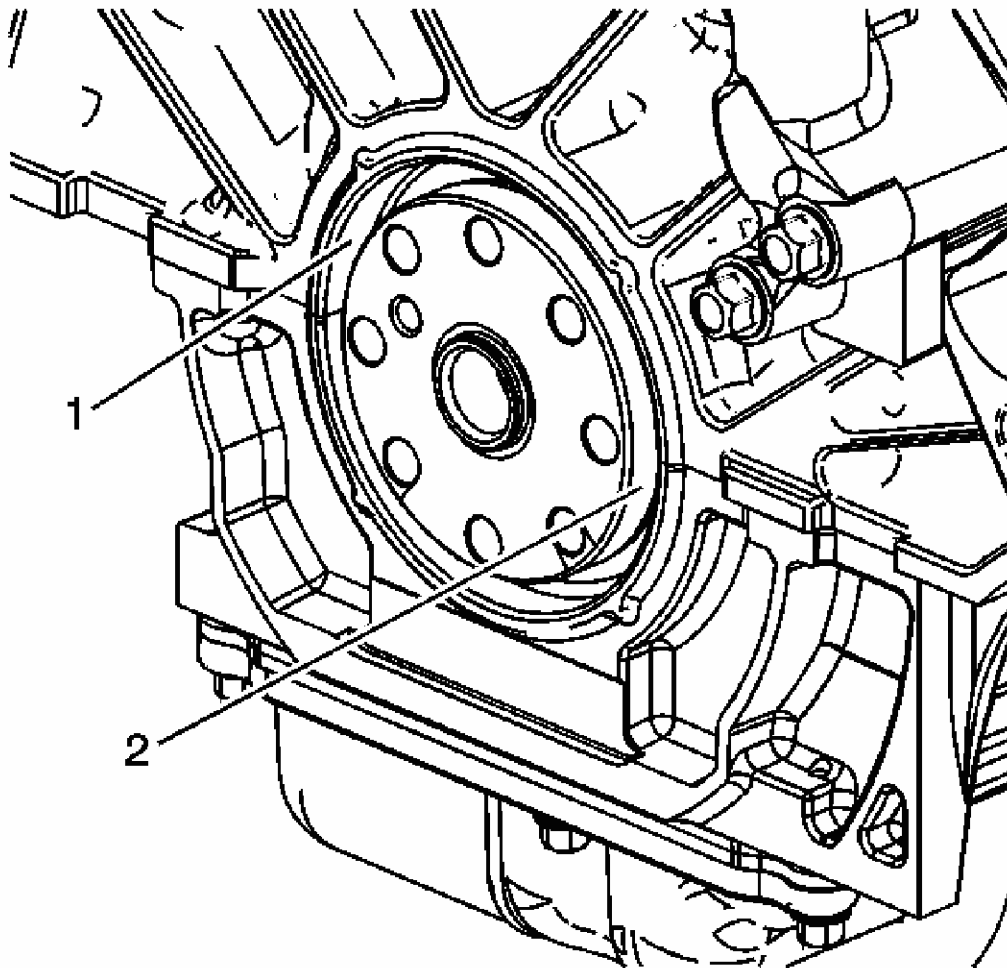


Fig. 7: Identifying Rear Crankshaft Seal Bore & Flange
Courtesy of GENERAL MOTORS CORP.

2. Inspect the engine block bore (1) and the crankshaft flange (2) for the damage. Repair or replace any damaged components.

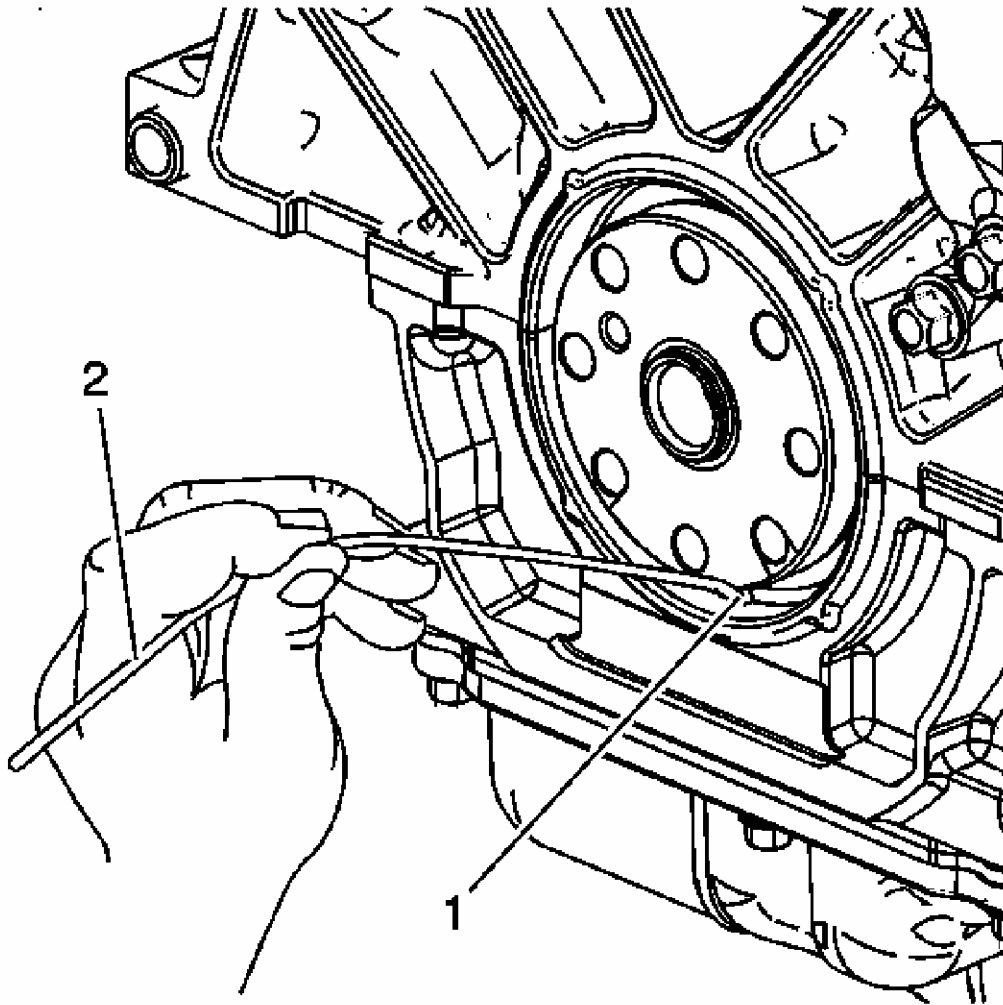


Fig. 8: Identifying Rear Oil Seal Drain
Courtesy of GENERAL MOTORS CORP.

3. Ensure the oil drain-back hole is clear of debris using a wire or an unbound plastic tie wrap.

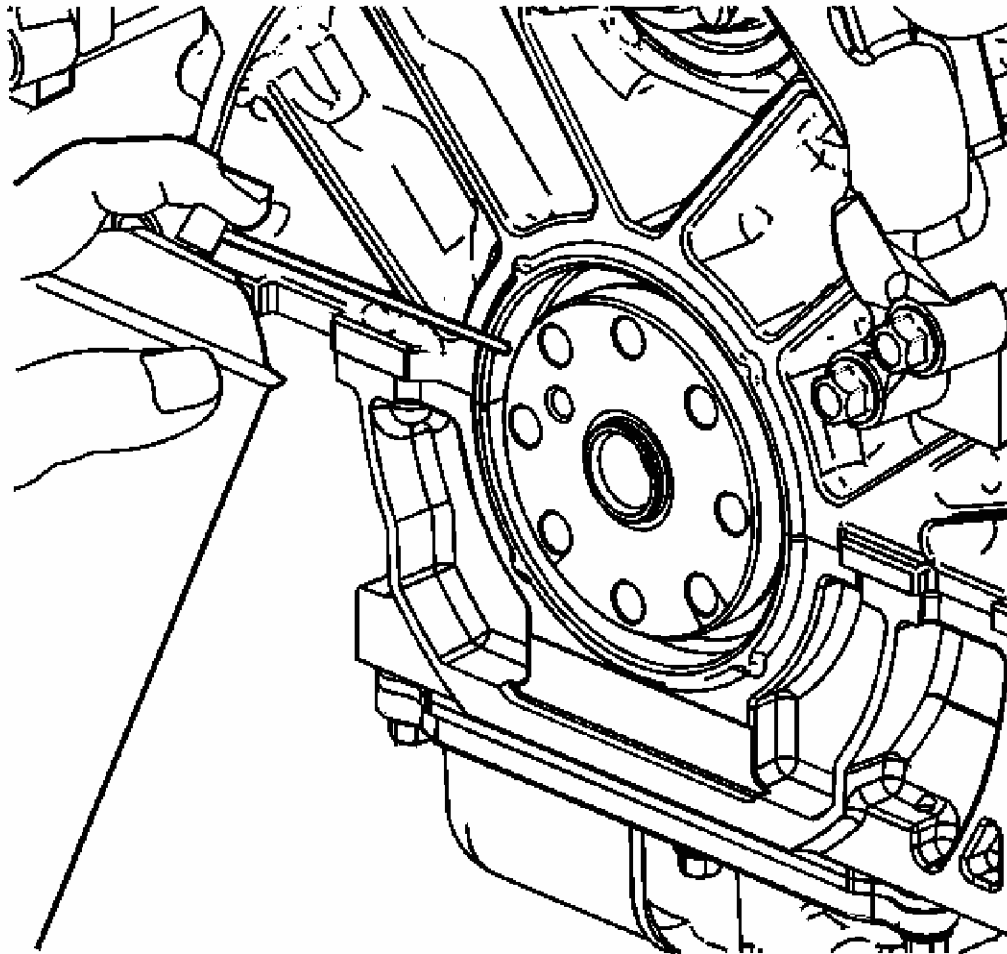


Fig. 9: Cleaning Rear Crankshaft Seal Bore
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: In order to ensure proper bonding of the sealant the bore must be clean and dry.

4. Clean the bore in the block with cleaner solvent GM P/N 12378392 or 12346139 (Canadian P/N 88901247).

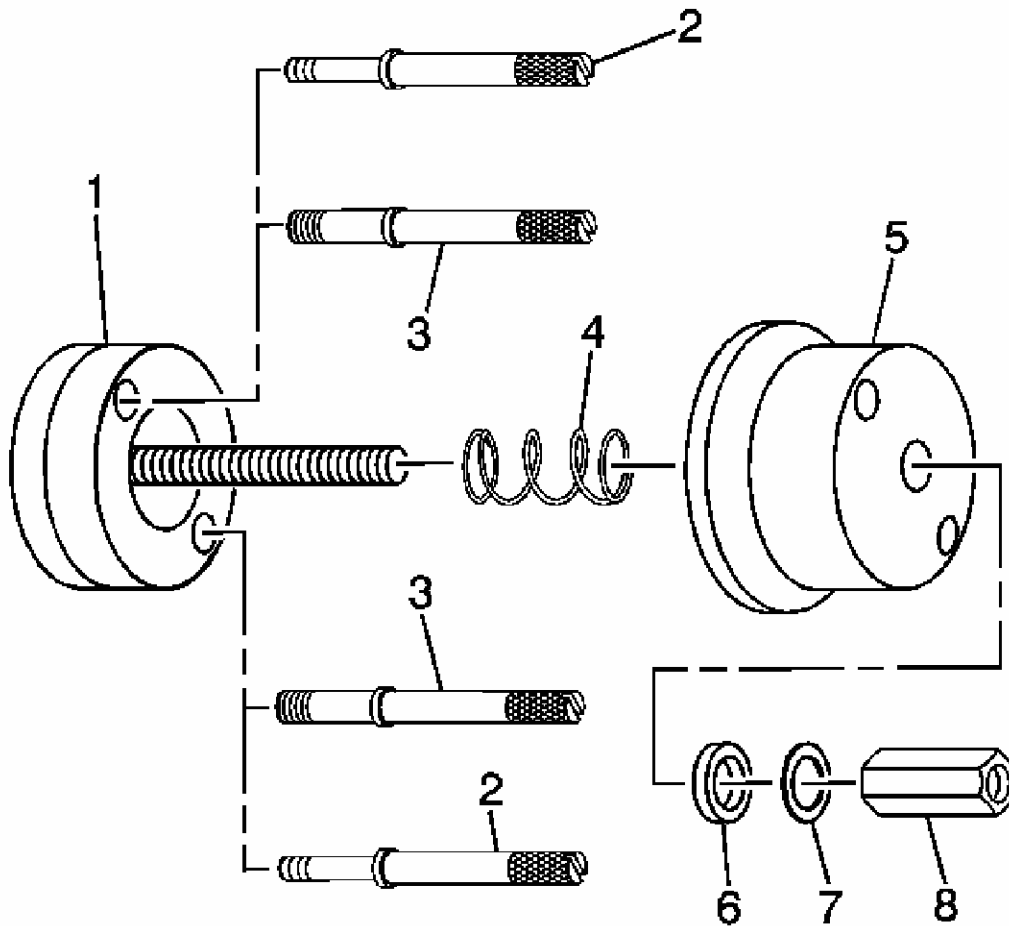


Fig. 10: View Of J 45930-A Tool Set
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Northstar engines 2005 and older have an 8 x 1.25 mm flywheel/flexplate crankshaft bolt hole thread. Northstar engines 2006 and later have an 11 x 1.5 mm flywheel/flexplate crankshaft bolt hole thread.

5. Remove the proper sized bolts from the **J 45930-A** . See **Special Tools** . Use the bolts (2) 8 mm or the bolts (3) 11 mm.

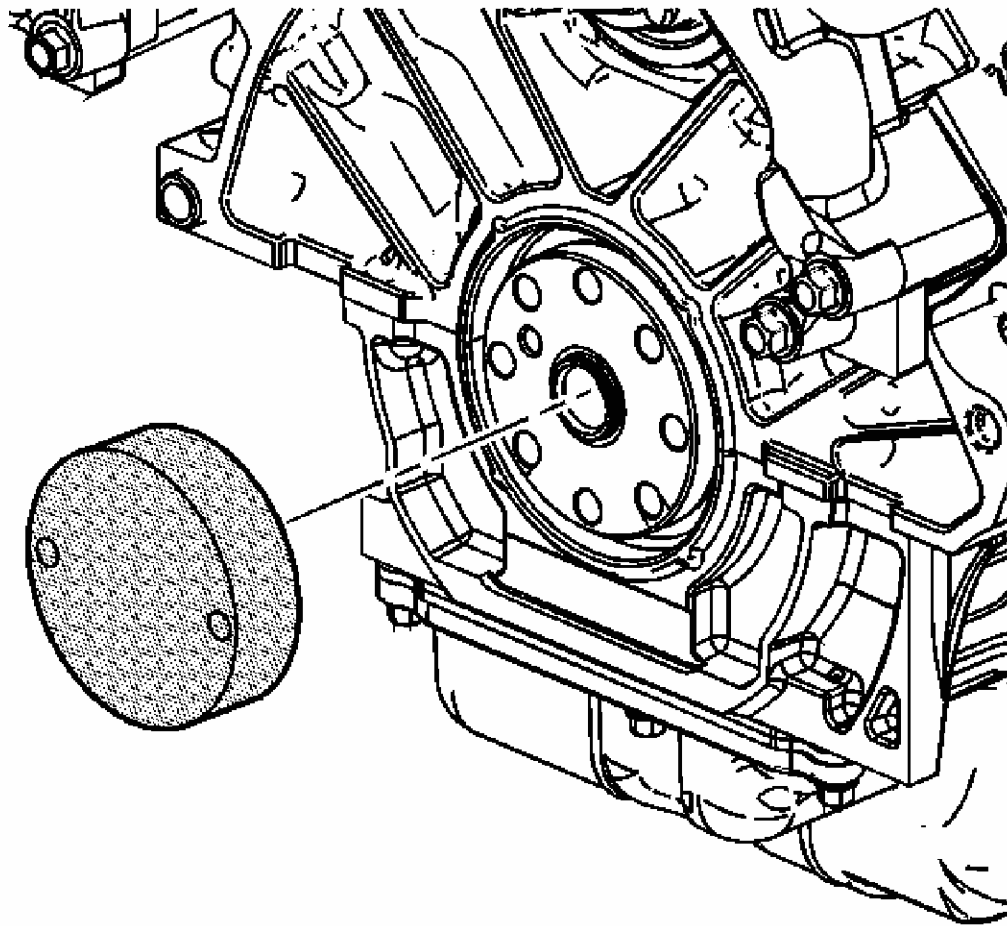


Fig. 11: Identifying Rear Seal Pilot Base
Courtesy of GENERAL MOTORS CORP.

6. Install the **EN-48072** pilot base onto the crankshaft. See **Special Tools** . The hub on the crankshaft will fit into the recess on the inboard side of the **EN-48072** pilot base. See **Special Tools** .

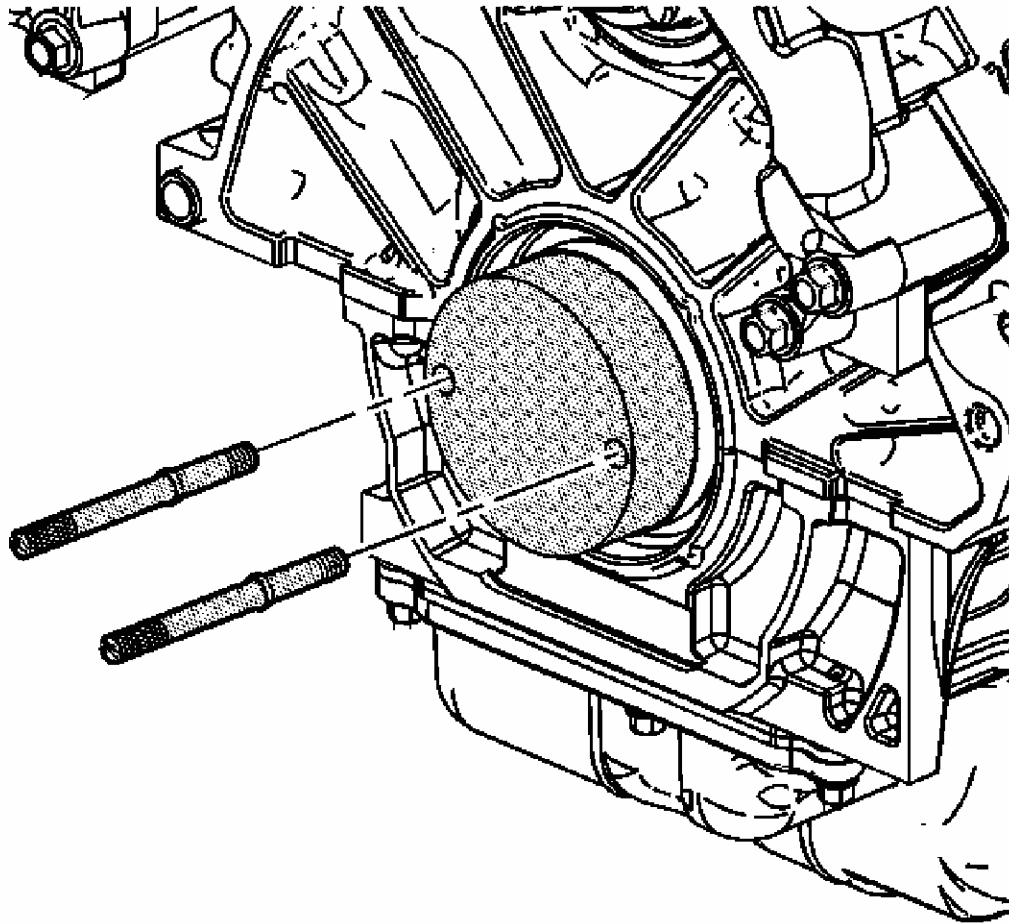


Fig. 12: View Of Pilot Base Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Northstar engines 2005 and older have an 8 x 1.25 mm flywheel/flexplate crankshaft bolt hole thread. Northstar engines 2006 and later have an 11 x 1.5 mm flywheel/flexplate crankshaft bolt hole thread.

7. Use the proper bolts from the **J 45930-A** to retain the **EN-48072** pilot base in place. See **Special Tools** .

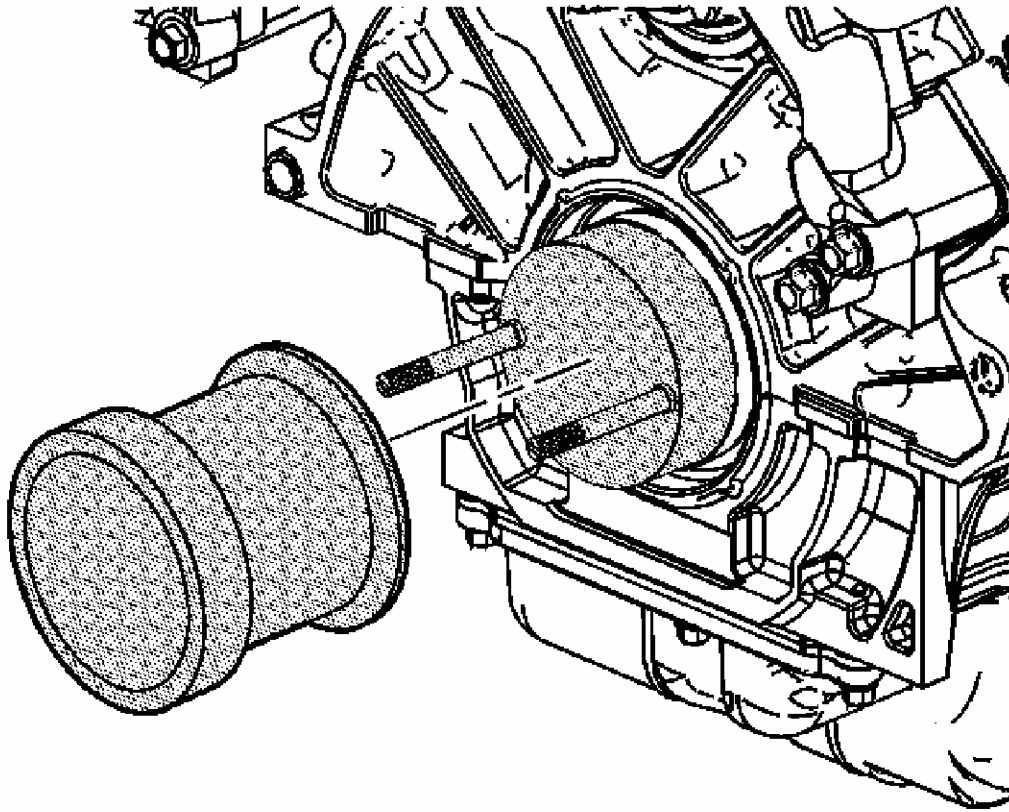


Fig. 13: View Of Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS CORP.

8. Install the **EN-48072** applicator housing over the **EN-48072** pilot base. See **Special Tools** . Ensure the **EN-48072** applicator housing bottoms in the bore of the block. See **Special Tools** .

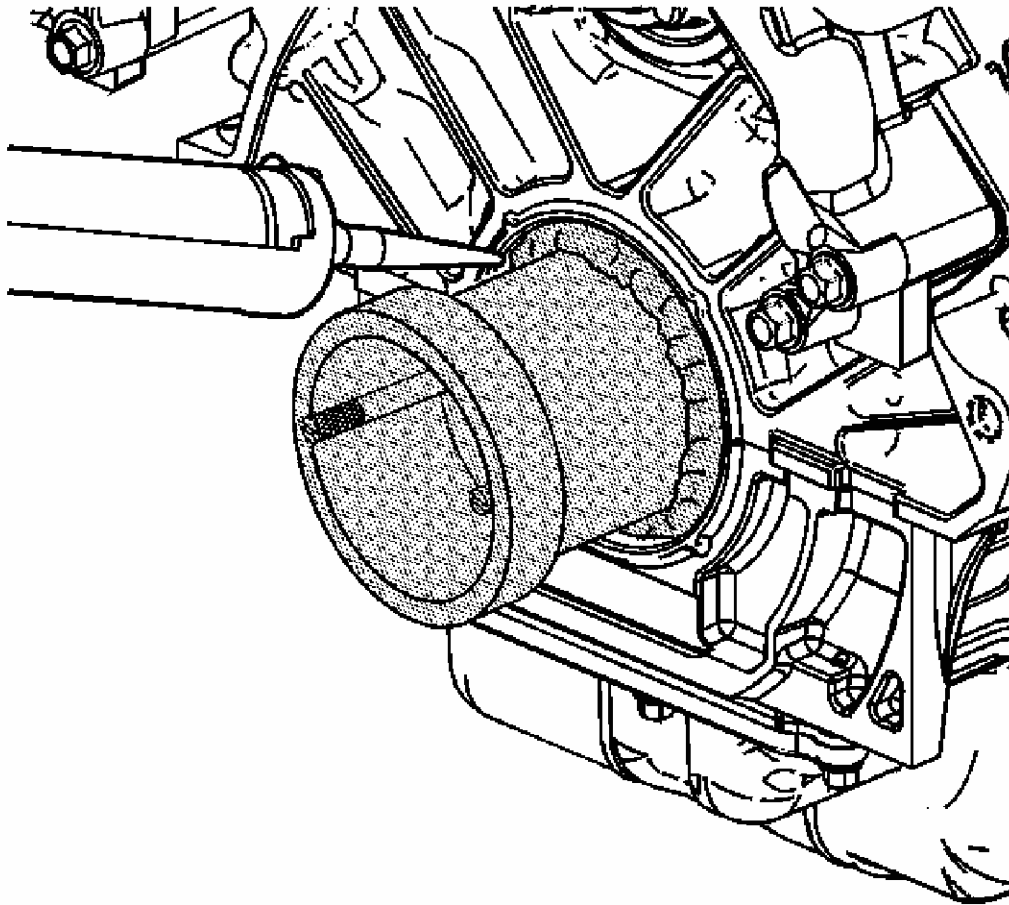


Fig. 14: Applying Sealant To Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The sealant must not block the drain back hole. Blockage of the drain back hole can lead to oil leakage.

9. Apply the sealant GM P/N 12378521 (Canadian P/N 88901148) to the bore outer diameter in the block. Ensure the sealant does not block the drain hole.

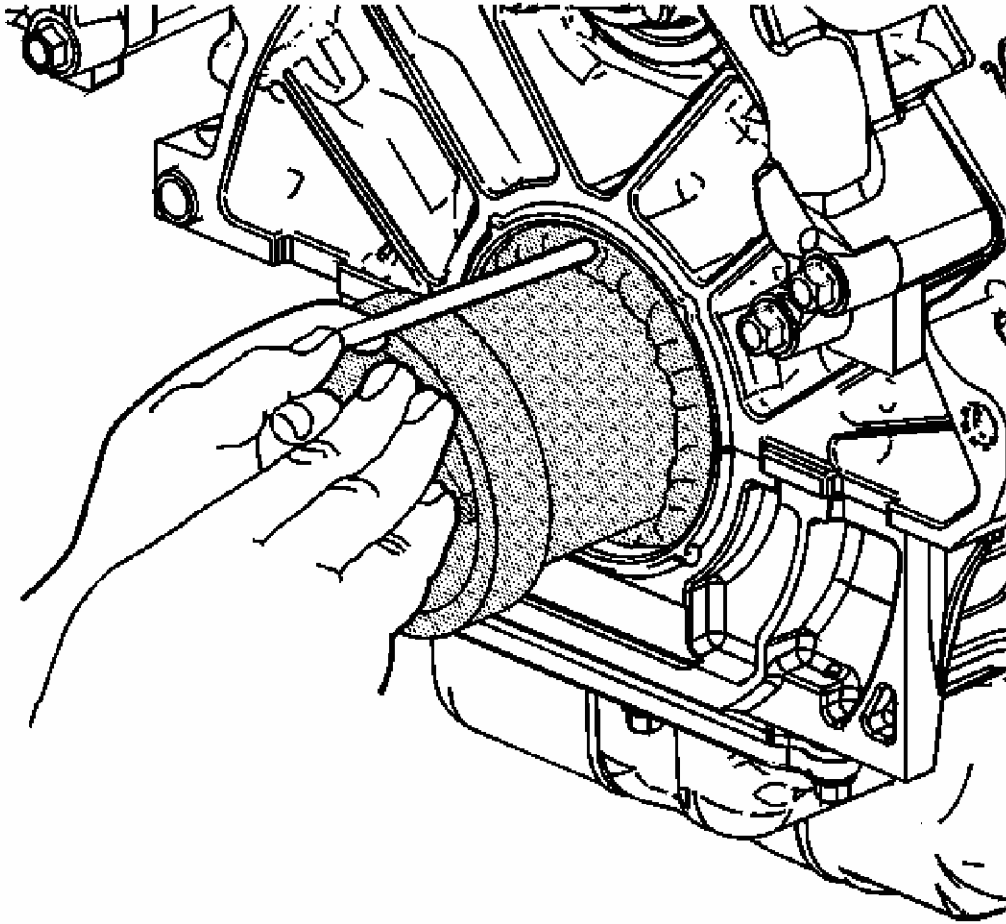


Fig. 15: Spreading Sealant To Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Apply steady even pressure to the EN-48072 applicator housing. See Special Tools .

10. Using a suitable tool spread the sealant within the bore to ensure an even coating across the bore.

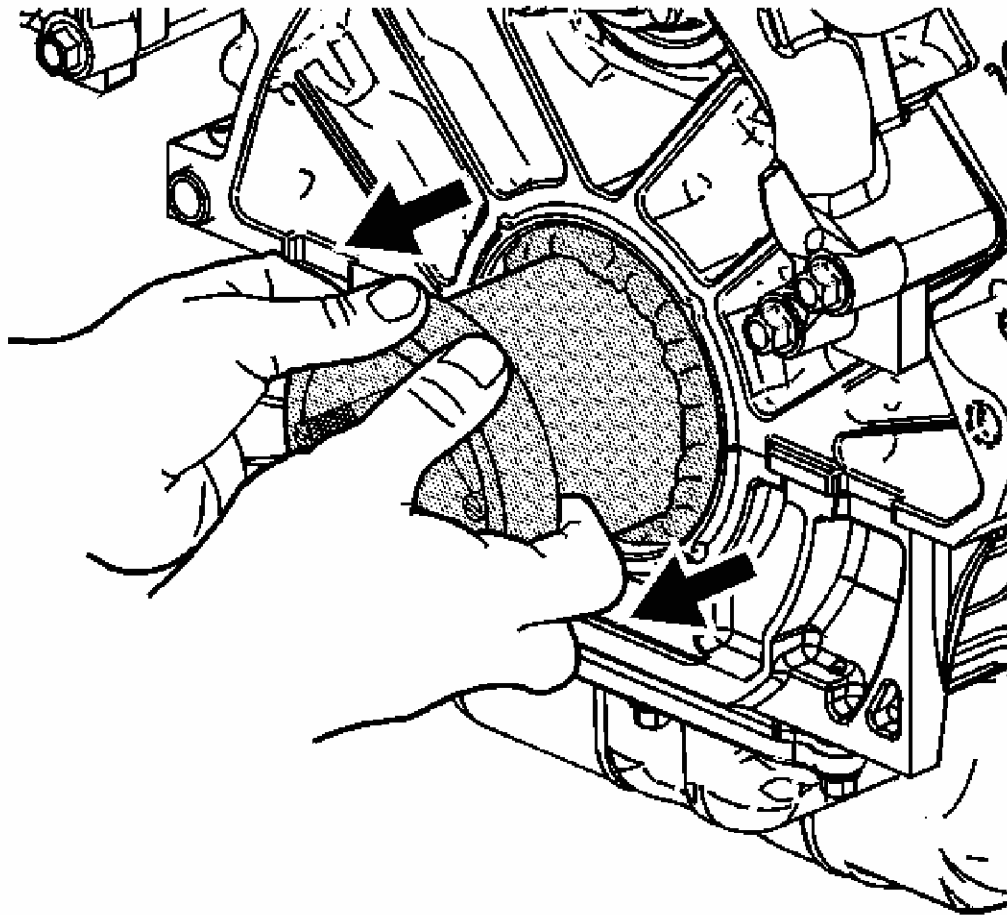


Fig. 16: Removing Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: In order to apply an even coat of the sealant do not twist or turn the EN-48072 applicator housing as it is pulled away from the bottom of the bore. See Special Tools .

11. Using both hands, slowly and evenly, pull the **EN-48072** applicator housing out of the bore and remove it from the **EN-48072** pilot base. See Special Tools .

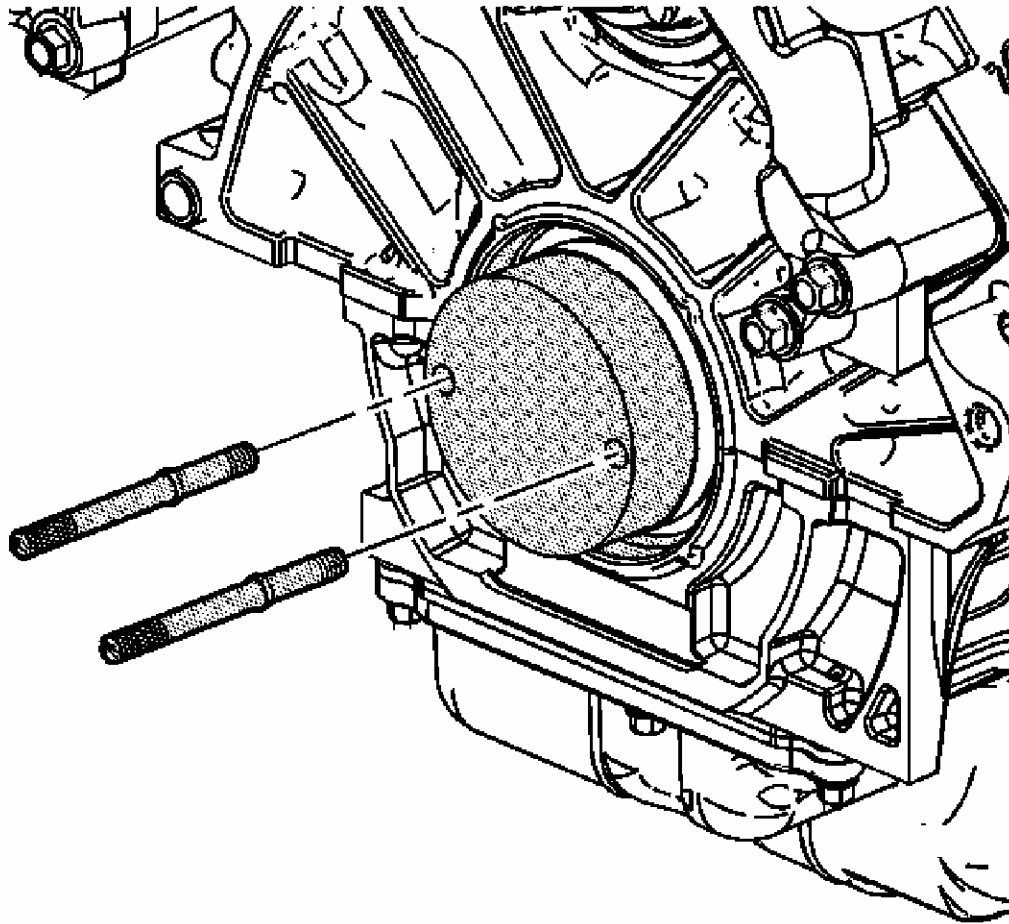


Fig. 17: Identifying Pilot Base Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

12. Remove the **J 45930-A** bolts from the **EN-48072** pilot base. See **Special Tools** .

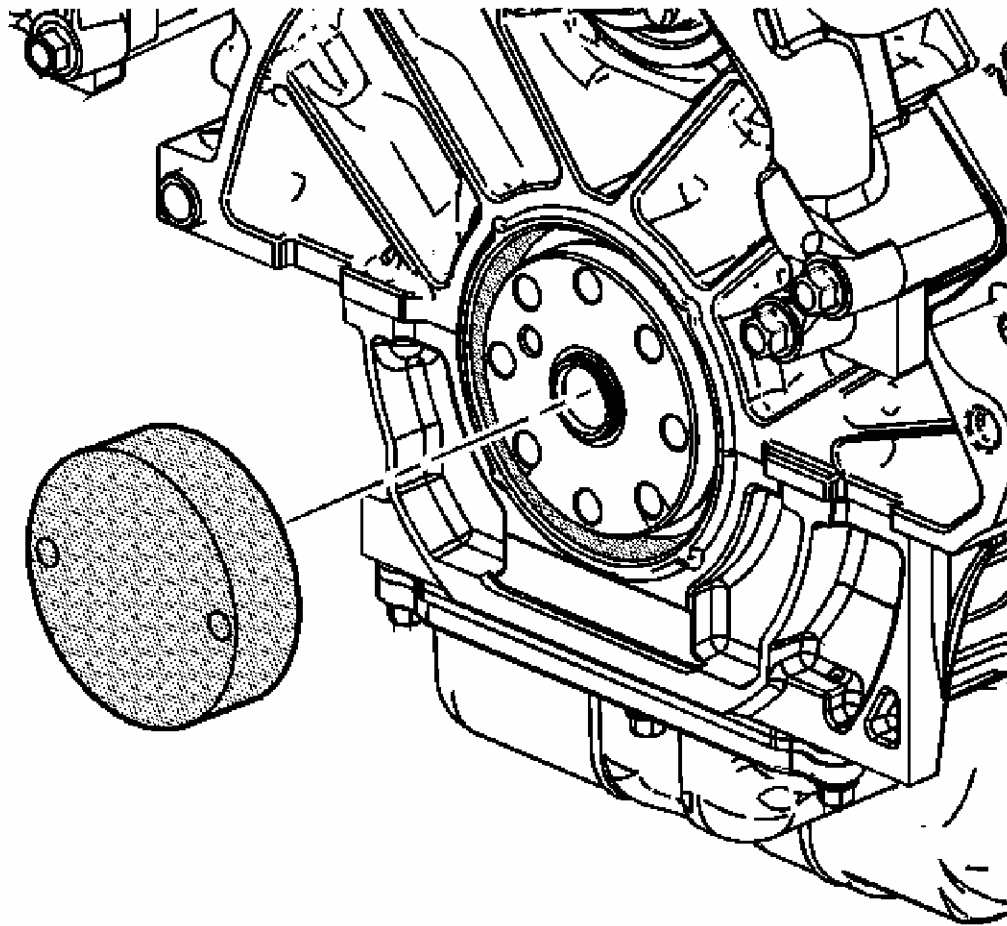


Fig. 18: View Of Rear Seal Pilot Base
Courtesy of GENERAL MOTORS CORP.

13. Remove the **EN-48072** pilot base. See **Special Tools** .

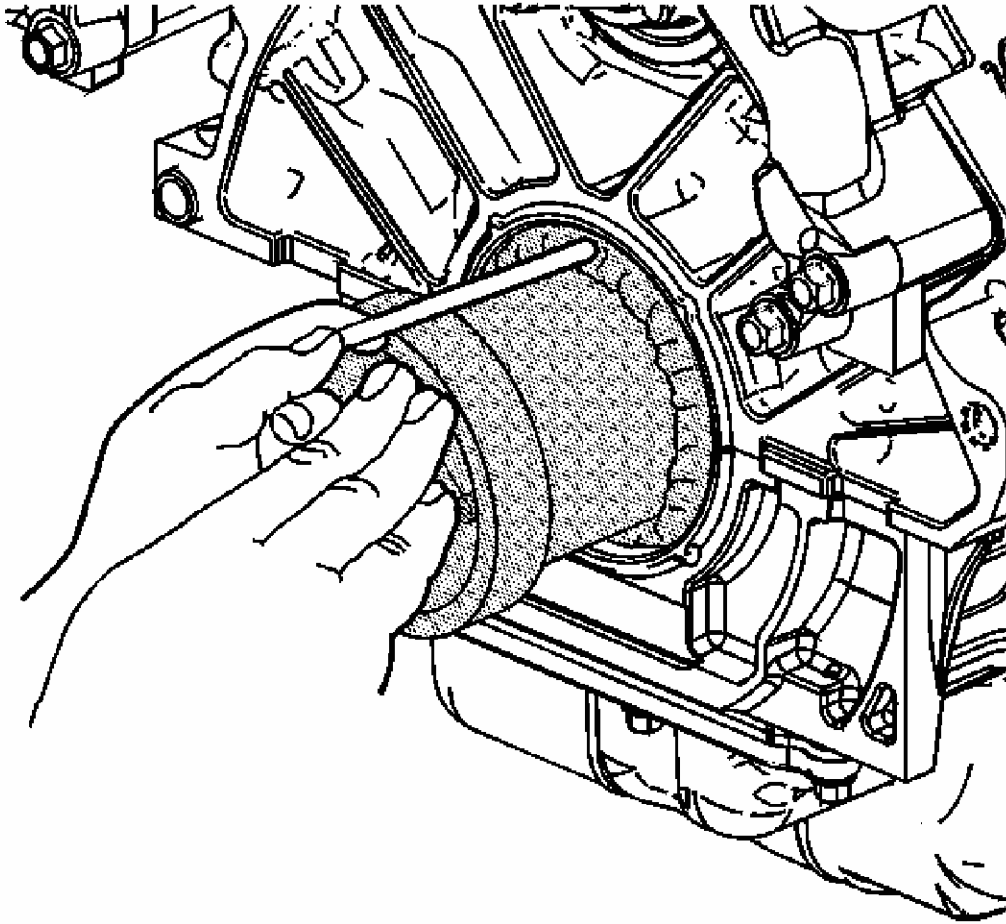


Fig. 19: Spreading Sealant To Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Apply steady even pressure to the EN-48072 applicator housing. See Special Tools .

14. Using a suitable tool spread the sealant within the bore to ensure an even coating across the bore.

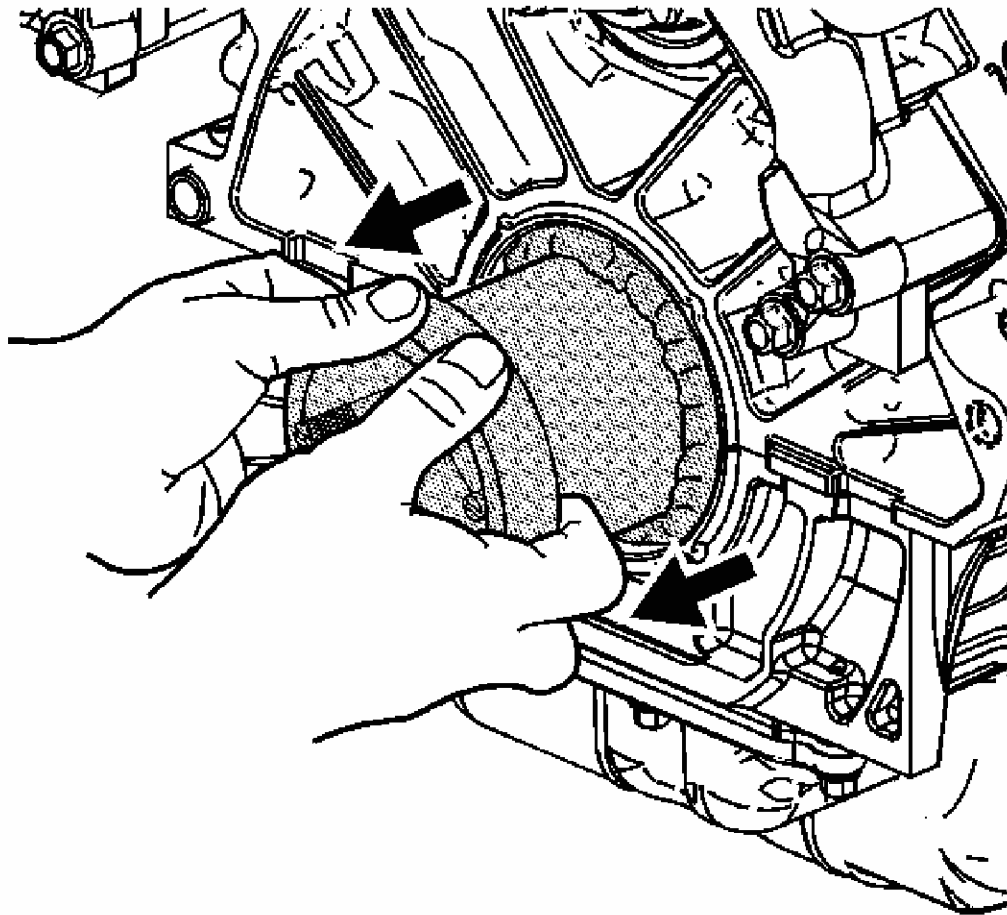


Fig. 20: Removing Rear Seal Applicator Housing
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: In order to apply an even coat of the sealant do not twist or turn the EN-48072 applicator housing as it is pulled away from the bottom of the bore. See Special Tools .

15. Using both hands, slowly and evenly, pull the **EN-48072** applicator housing out of the bore and remove it from the **EN-48072** pilot base. See Special Tools .

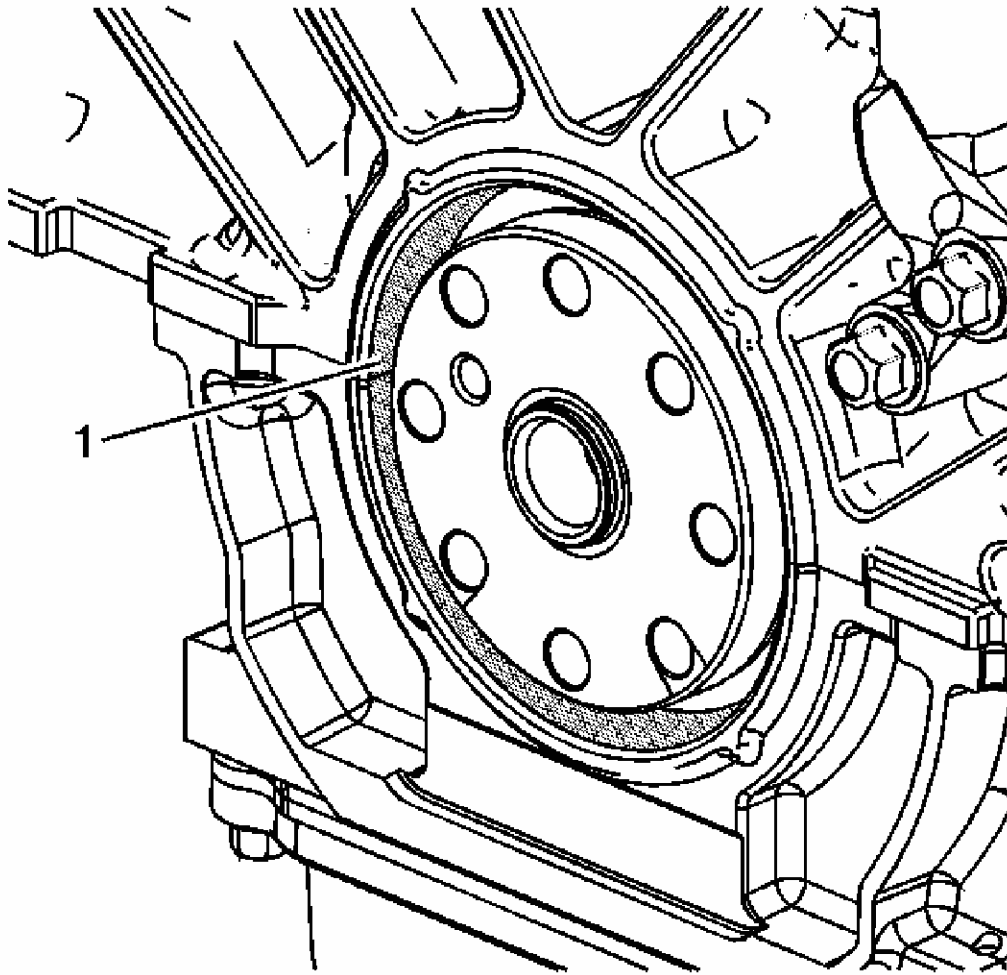


Fig. 21: Spreading Sealant Across Bore Of Block
Courtesy of GENERAL MOTORS CORP.

16. Ensure that the sealant (1) is evenly spread across the bore of the block.

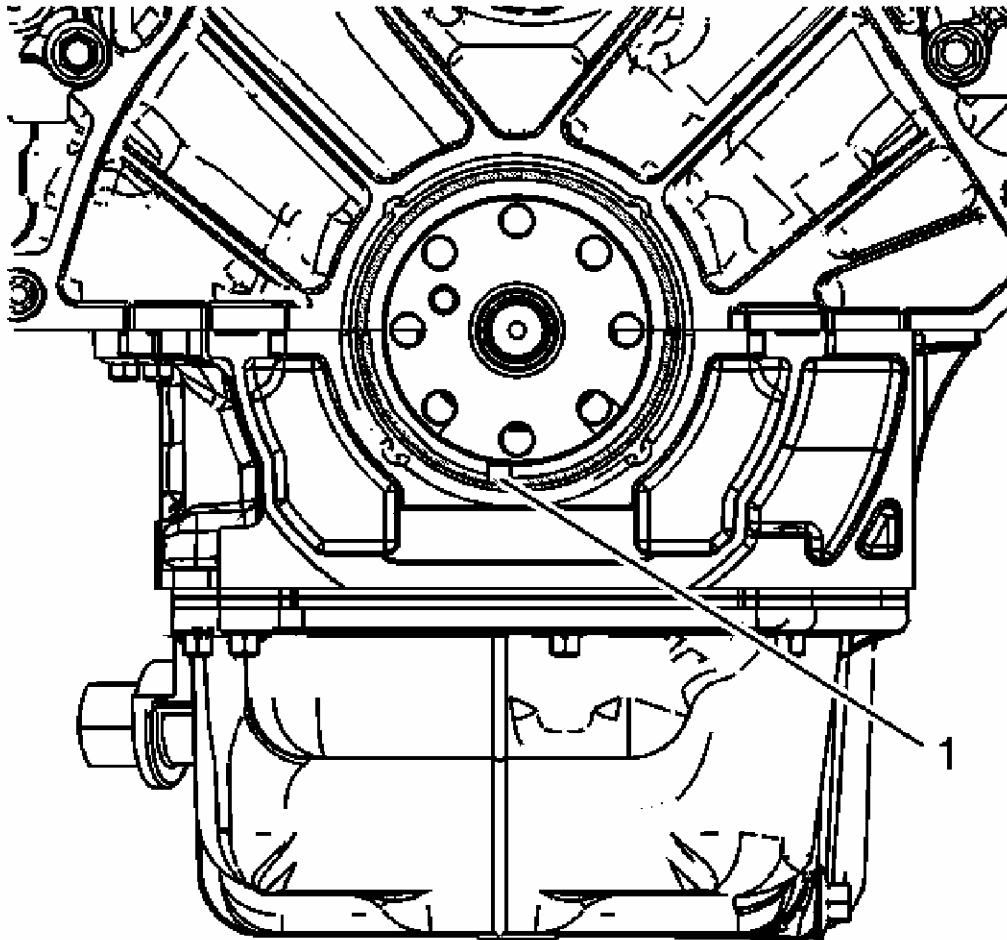


Fig. 22: Checking Seal Bore Drain Back Hole
Courtesy of GENERAL MOTORS CORP.

17. Ensure the drain back hole (1) is clear of the sealant.

IMPORTANT: Beginning with the model year 2006 the flywheel/flexplate crankshaft bolt hole thread was changed from 8 x 1.25 mm to 11 x 1.5 mm. The J 45930-A will service the cassette seals installed on engines from March 1, 1996 to 2006. See Special Tools . If a J 45930 is to be used on a 2006 or later engine the update kit, J 45930-10, must be used to convert the J 45930 to a J 45930-A . See Special Tools .

IMPORTANT: Crankshaft rear oil seal and engine flywheel installation

requires adequate space for installation. If the engine stand does not allow suitable space to use the J 45930-A install the crankshaft rear oil seal and engine flywheel with the engine properly supported on the floor or on a bench. See Special Tools .

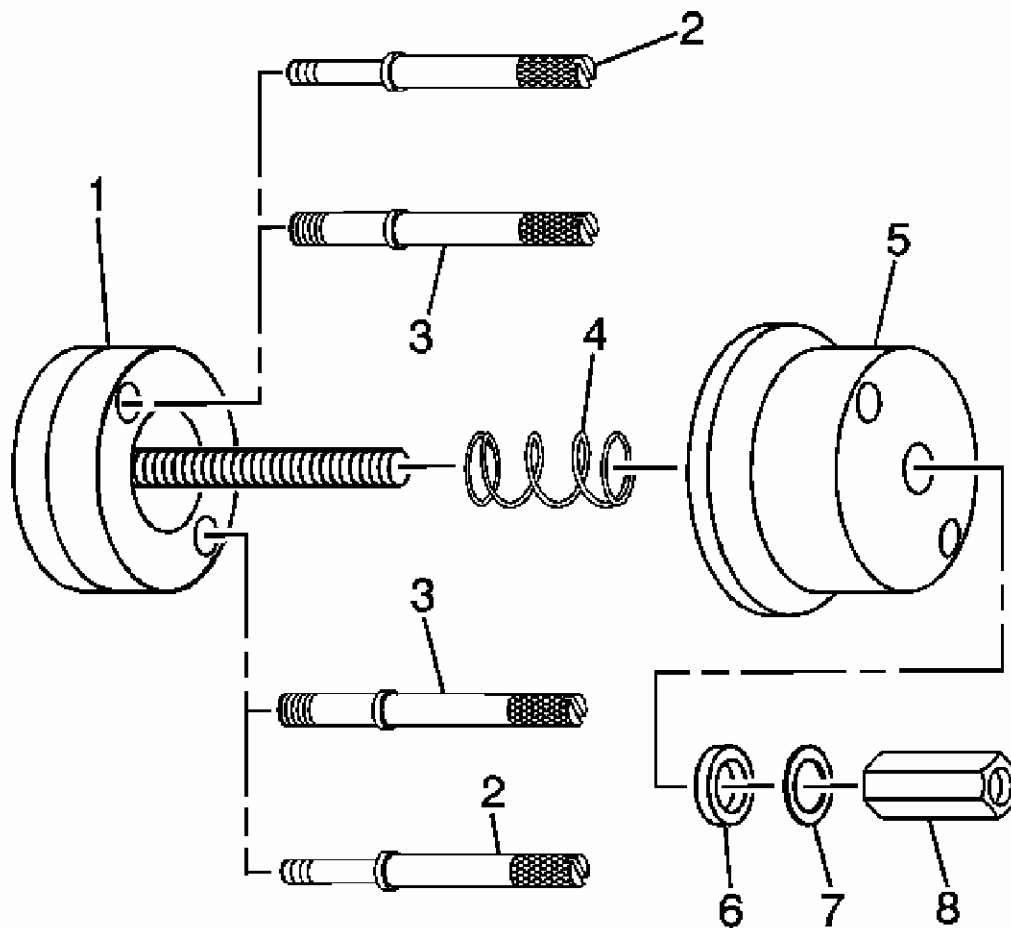


Fig. 23: View Of J 45930-A Tool Set
 Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Northstar engines 2005 and older have an 8 x 1.25 mm flywheel/flexplate crankshaft bolt hole thread. Northstar engines 2006 and later have an 11 x 1.5 mm flywheel/flexplate crankshaft bolt hole thread.

18. Ensure the proper size of bolt (2) 8 mm or (3) 11 mm is being installed in the J 45930-

A . See Special Tools .

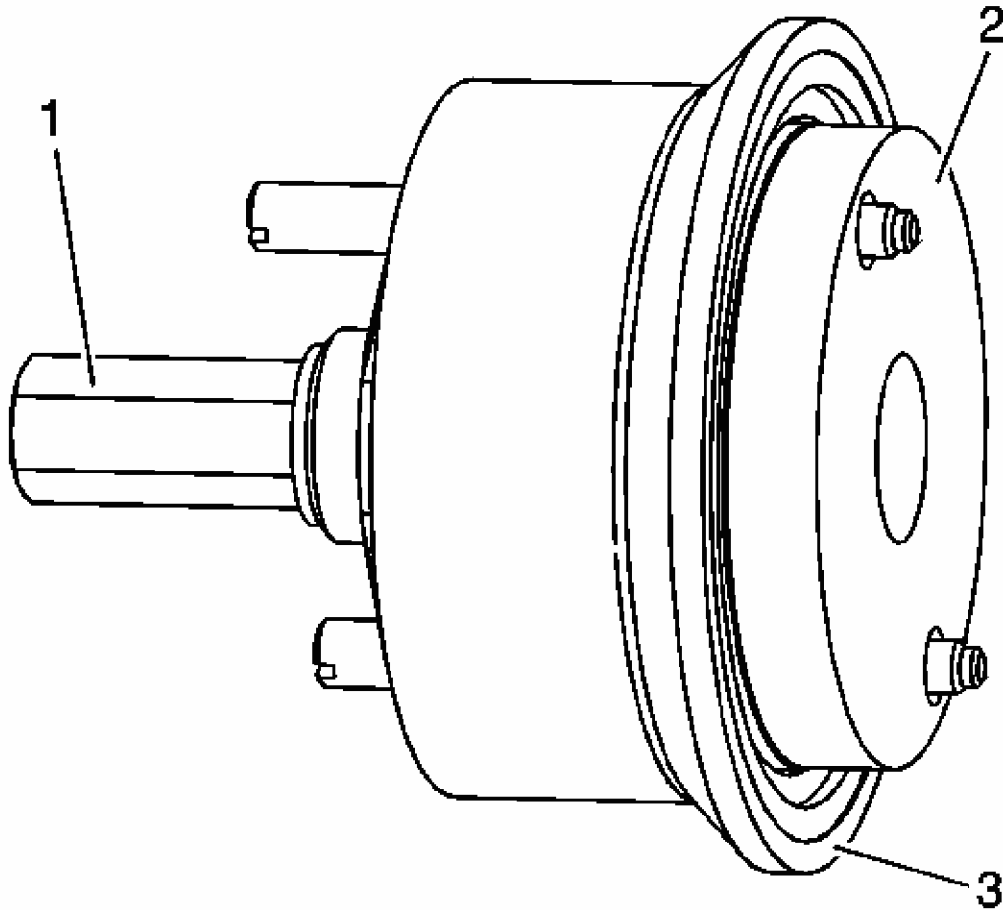


Fig. 24: View Of J 45930-A Crankshaft Rear Oil Seal Installer
Courtesy of GENERAL MOTORS CORP.

19. Turn the center nut (1) of the **J 45930-A** until the center hub (2) protrudes approximately 15 mm (0. See Special Tools .591 in) beyond the outer plate (3).

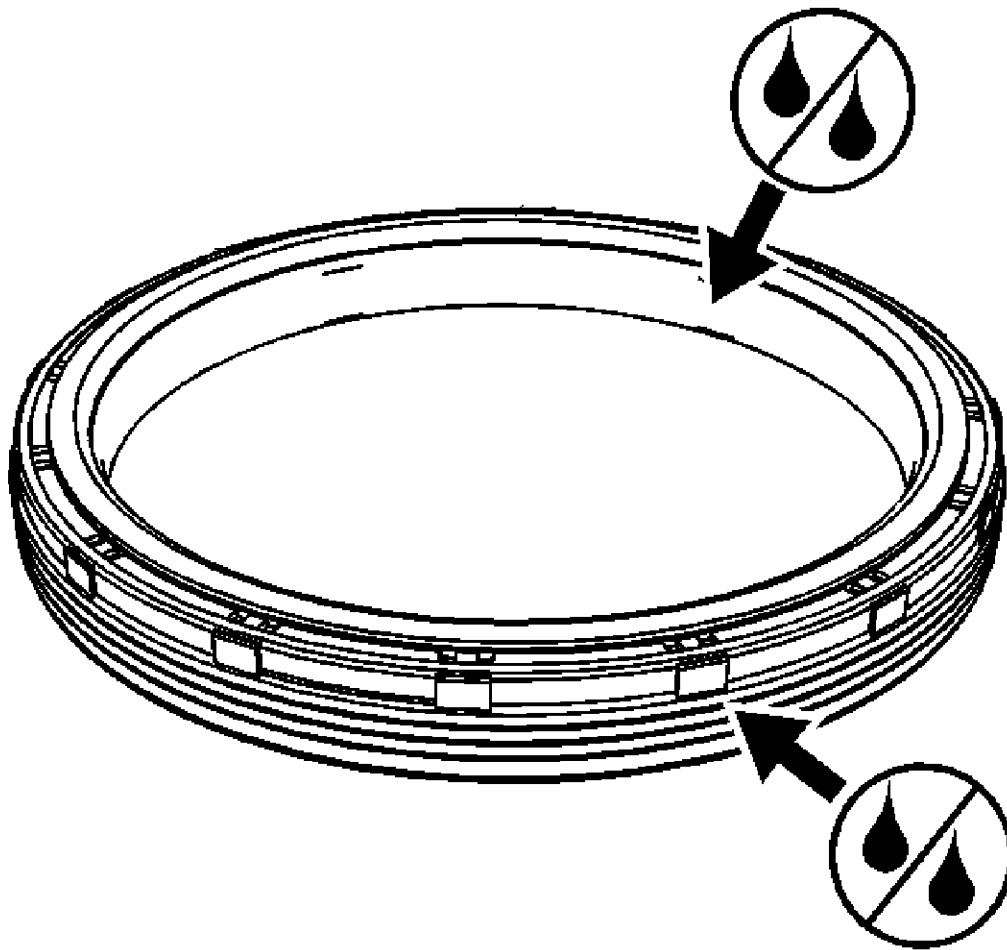


Fig. 25: Identifying Rear Seal Lubrication Points
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT use any lubricant in order to install the crankshaft rear oil seal. Do not use any lubricant on the coating pre-applied to the inner diameter of the crankshaft rear oil seal. The coating is a sealant that must not be contaminated. Do not use any lubricant on the outer diameter of the crankshaft rear oil seal. The sealant applied to the bore of the engine block will not properly bond to a lubricated crankshaft rear oil seal.

20. Do not lubricate any part of the new cassette style crankshaft rear oil seal.

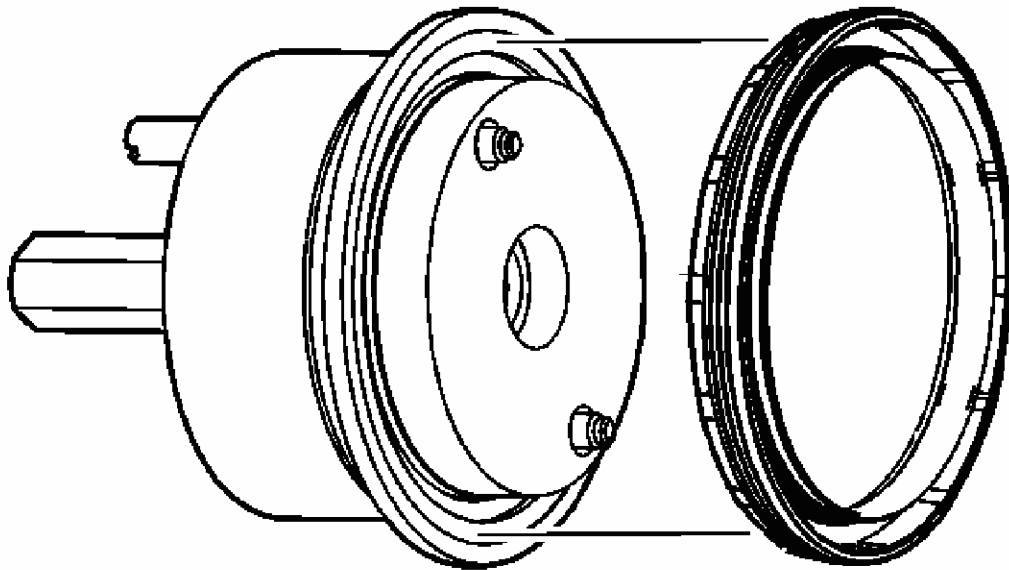


Fig. 26: Positioning Rear Seal Onto J 45930-A Crankshaft Rear Oil Seal Installer
Courtesy of GENERAL MOTORS CORP.

21. Install the new cassette style crankshaft rear oil seal onto the center hub of the **J 45930-A** . See **Special Tools** .

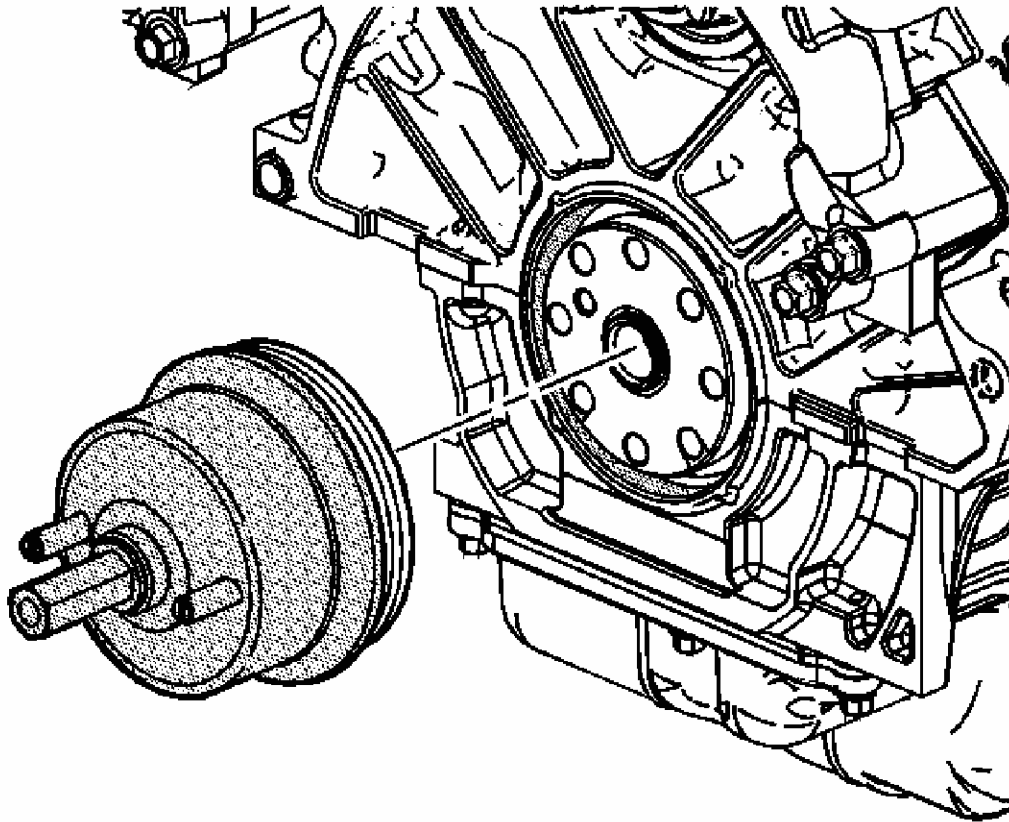


Fig. 27: Threading J 45930-A Mounting Bolts Into Crankshaft
Courtesy of GENERAL MOTORS CORP.

22. Thread the two **J 45930-A** mounting bolts into the crankshaft flywheel bolt holes. See **Special Tools** .

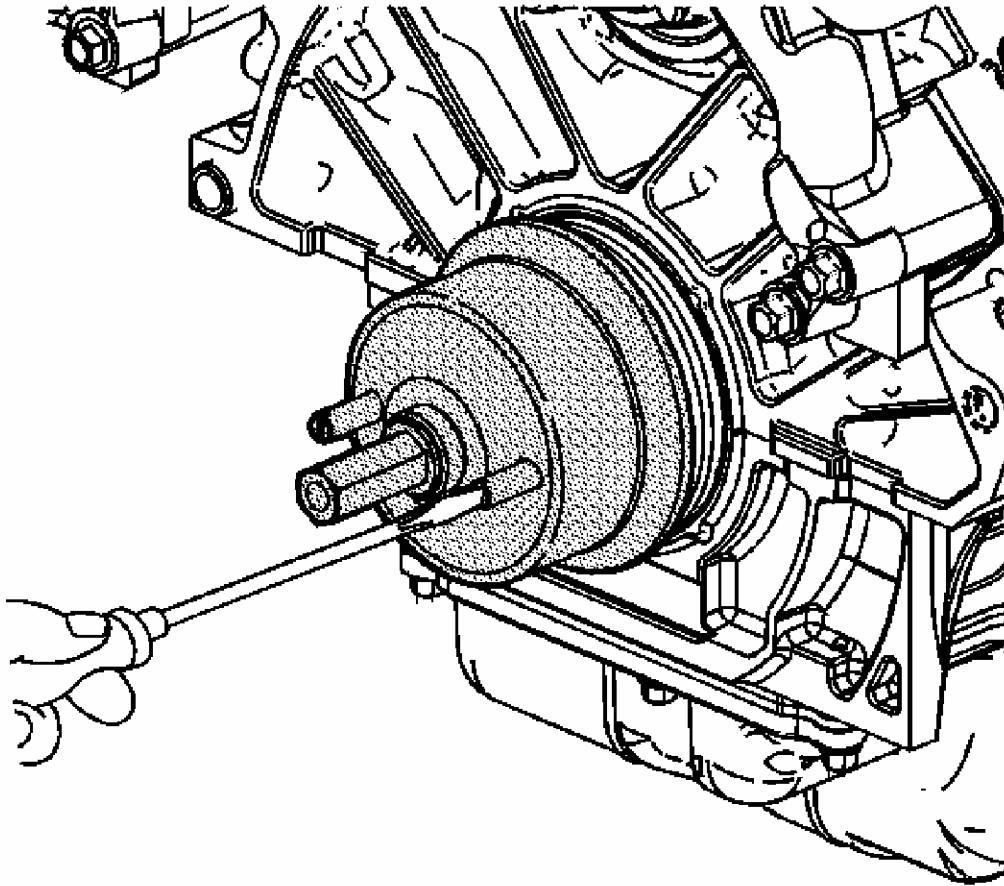


Fig. 28: Checking Seal Installer Tightness
Courtesy of GENERAL MOTORS CORP.

23. Tighten the two mounting bolts until the **J 45930-A** is firmly mounted on the crankshaft.
See **Special Tools** .

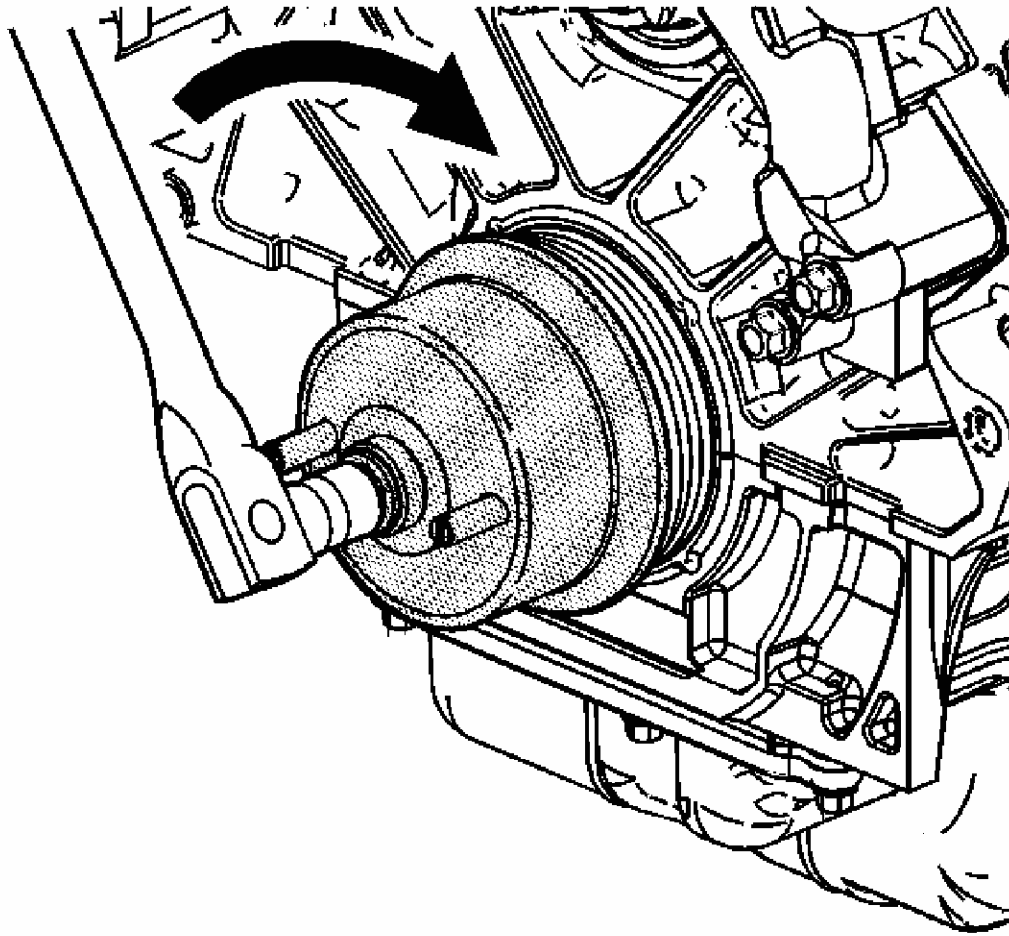


Fig. 29: Installing Crankshaft Rear Seal
Courtesy of GENERAL MOTORS CORP.

24. Install the new cassette style crankshaft rear oil seal by turning the nut of the **J 45930-A** until the drive portion of the **J 45930-A** bottoms against the crankcase. See **Special Tools** .

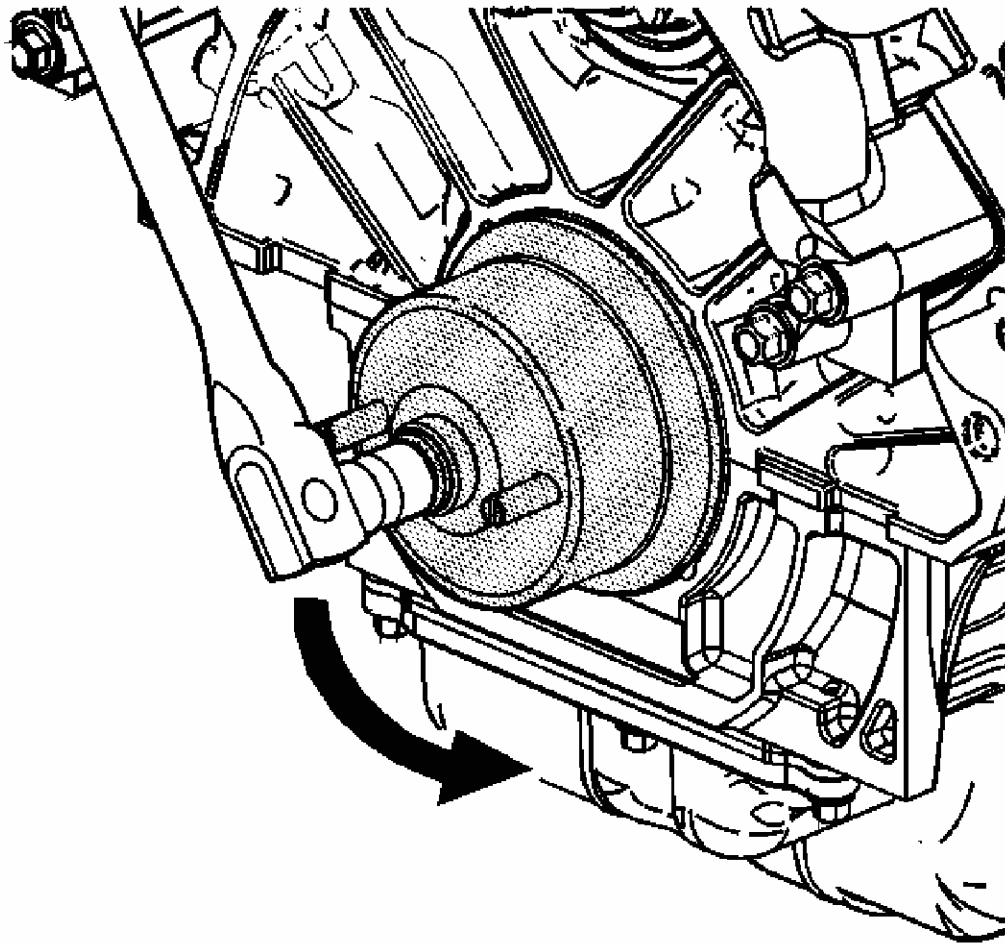


Fig. 30: Loosening Seal Installer Center Nut
Courtesy of GENERAL MOTORS CORP.

25. Loosen the center nut to release pressure on the crankcase.

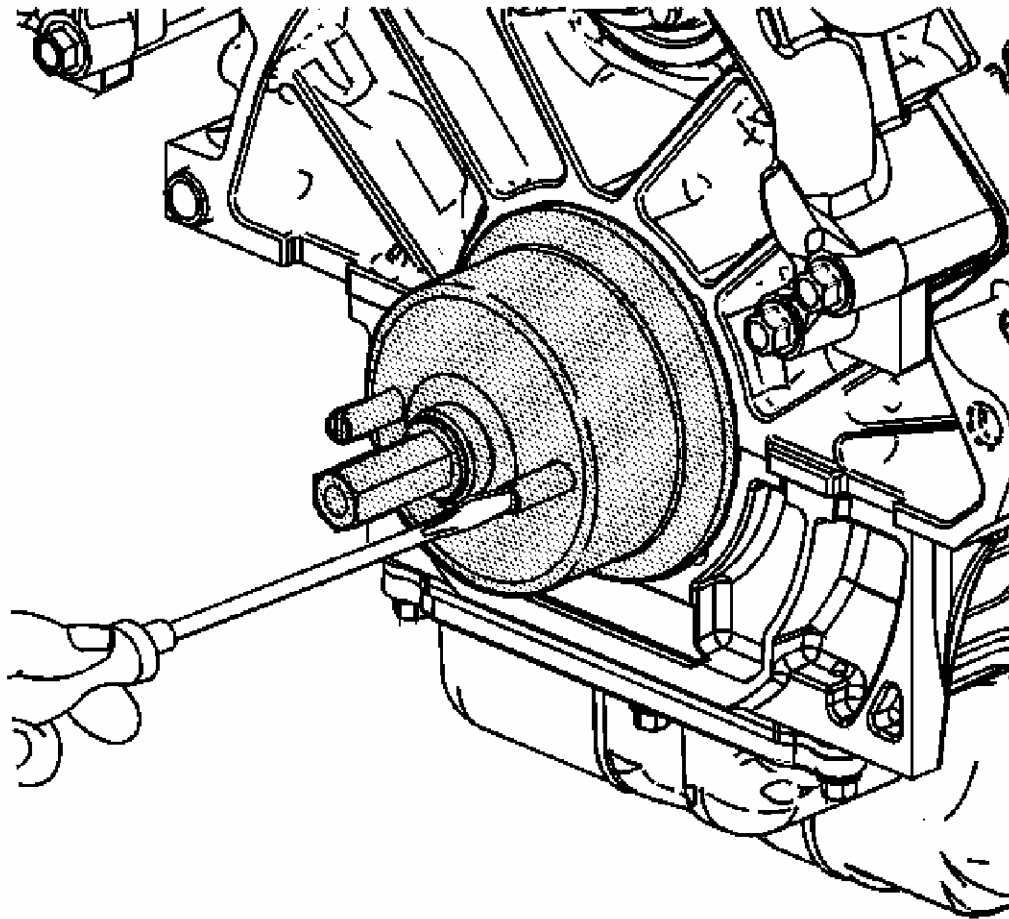


Fig. 31: Loosening Seal Installer Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

26. Loosen the two mounting bolts.

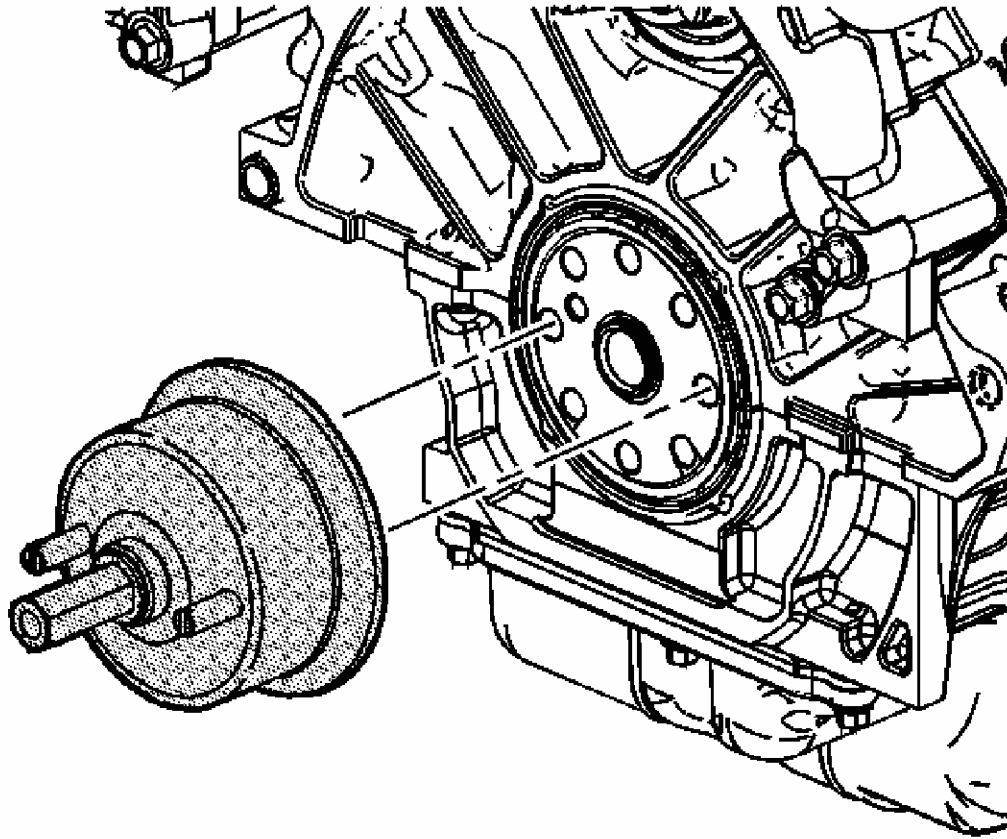


Fig. 32: Removing J 45930-A Seal Installer
Courtesy of GENERAL MOTORS CORP.

27. Remove the **J 45930-A** from the crankshaft. See **Special Tools** .
28. Wipe off any excessive sealant from the block.

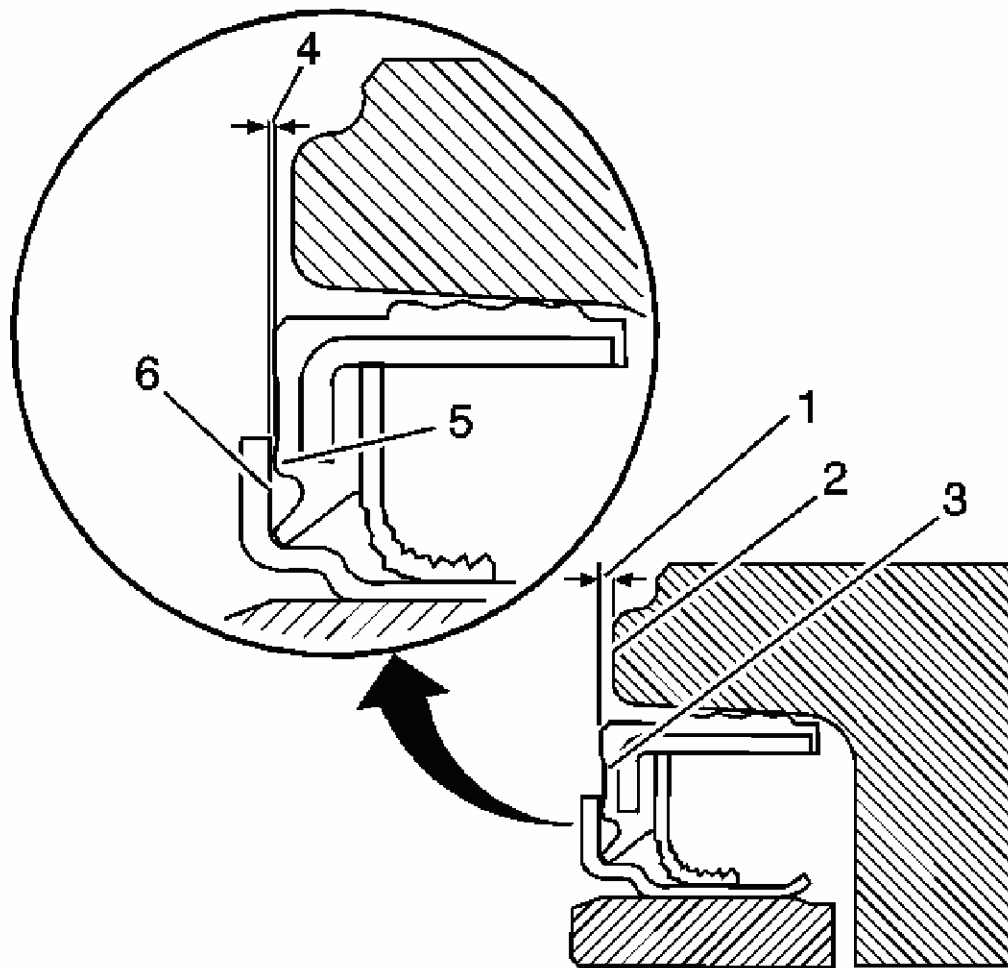


Fig. 33: Checking Seal Installation
Courtesy of **GENERAL MOTORS CORP.**

29. Ensure the new cassette style crankshaft rear oil seal is installed properly.
 - The outer surface of the seal (3) should be 0.500-0.800 mm (0.0197-0.0315 in) (1) below the surface of the engine block (2).
 - The inner surface of the sleeve (6) should be 0.400-0.900 mm (0.0158-0.0354 in) (4) below the surface of the outer surface of the seal (5).
 - The installed seal and sleeve need to be parallel to the block by 0.000-0.500 mm (0.000-0.0197 in).
30. Clean all tools to remove any residual sealant.
31. Install the flywheel. Refer to **Engine Flywheel Replacement**.
32. Install the transaxle. Refer to **Transmission Replacement**.

ENGINE REPLACEMENT

TOOLS REQUIRED

- **J 37097-A** Hose Clamp Remover/Installer. See **Special Tools** .
- **J 38185** Hose Clamp Pliers
- **J 39580** Universal Engine Support Table. See **Special Tools** .
- **J 41623-B** Cooler Quick Connect Tool. See **Special Tools** .
- **J 42640** Steering Column Lock Pin. See **Special Tools** .

REMOVAL PROCEDURE

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .
3. Recover the air conditioning (A/C) refrigerant system. Refer to **Refrigerant Recovery and Recharging** .

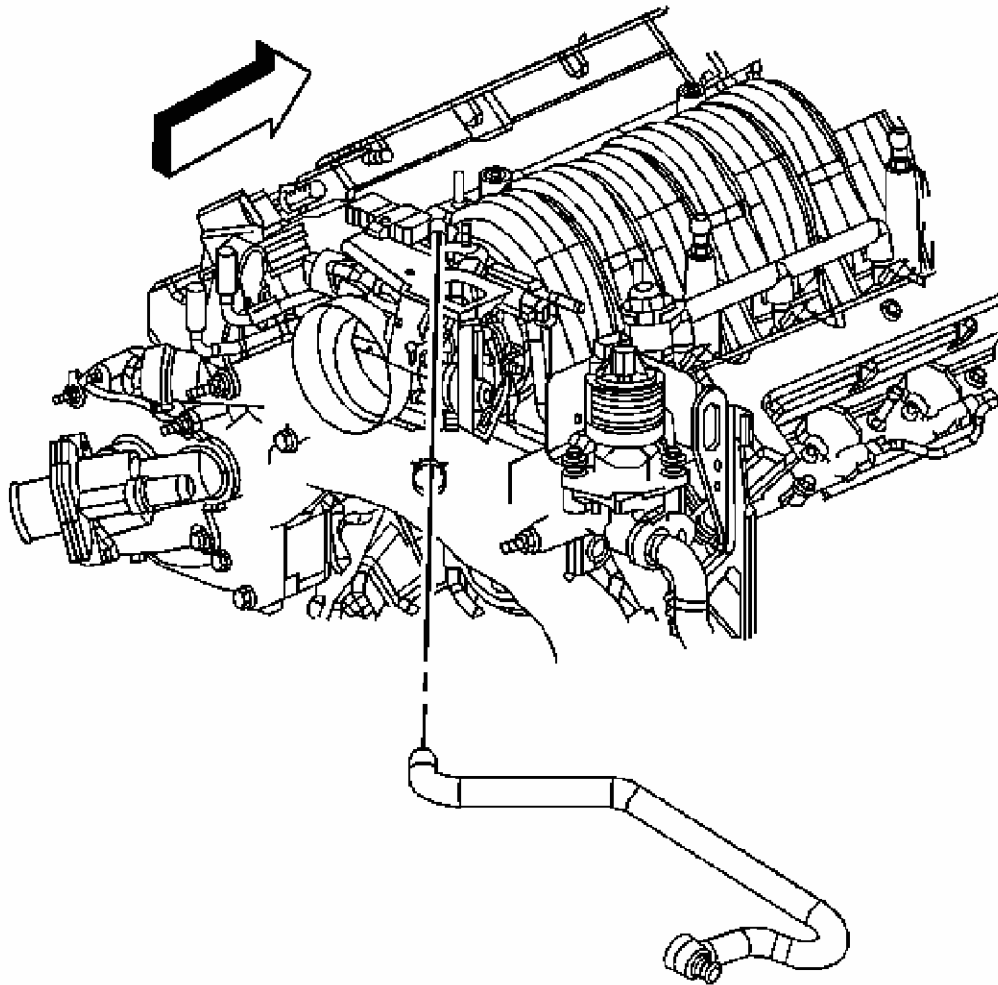


Fig. 34: View Of Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

4. Reposition the brake booster vacuum hose clamp at the engine port.
5. Disconnect the brake booster vacuum hose from the vacuum connection and position aside.

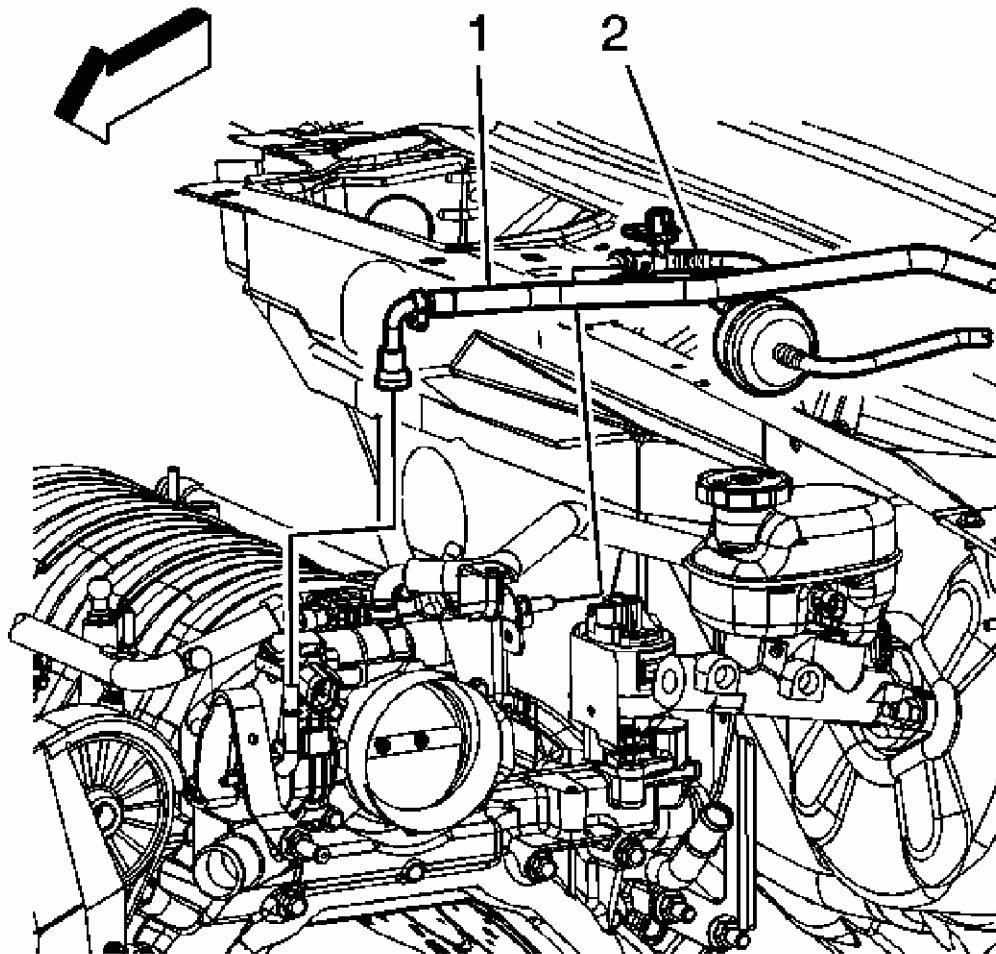


Fig. 35: Identifying Fuel Feed Pipe & EVAP Line Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the fuel feed and evaporative emission (EVAP) line quick-connect fittings (1, 2). Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service** .
7. Remove the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .
8. Remove the air cleaner. Refer to **Air Cleaner Assembly Replacement** .

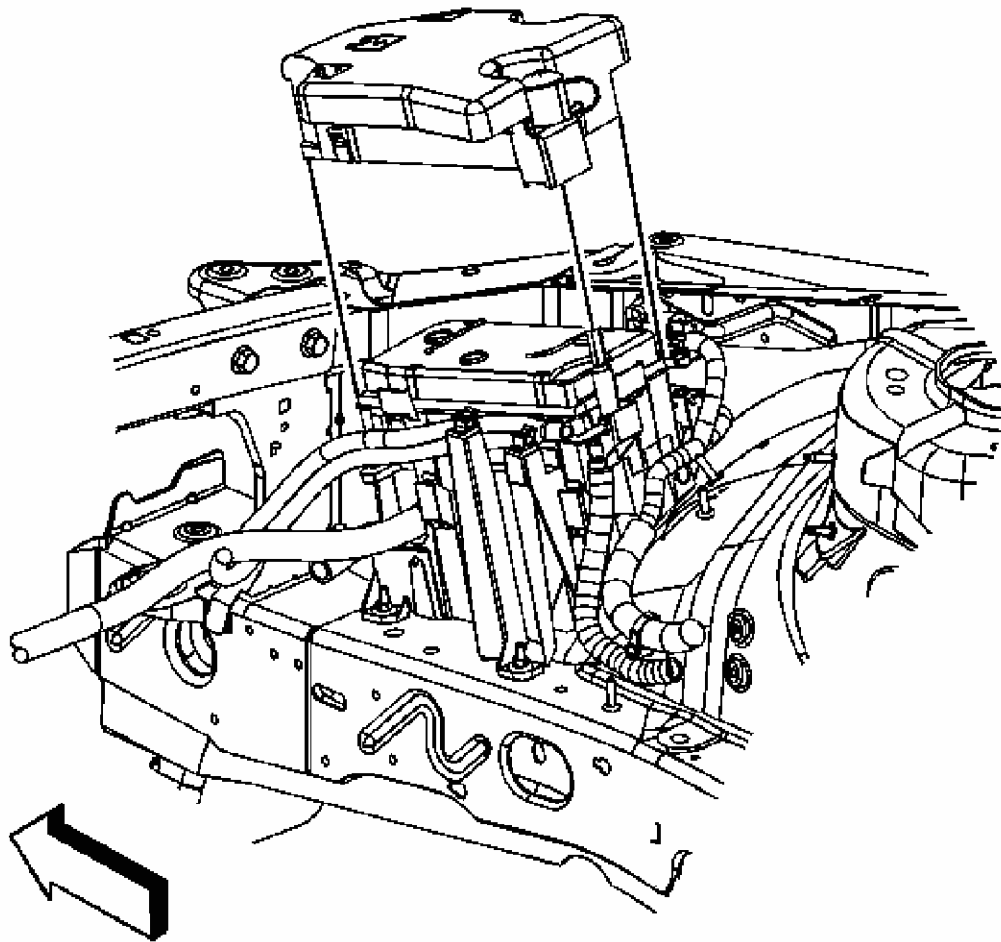


Fig. 36: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

9. Disengage the junction block cover lock tabs.
10. Remove the junction block cover.

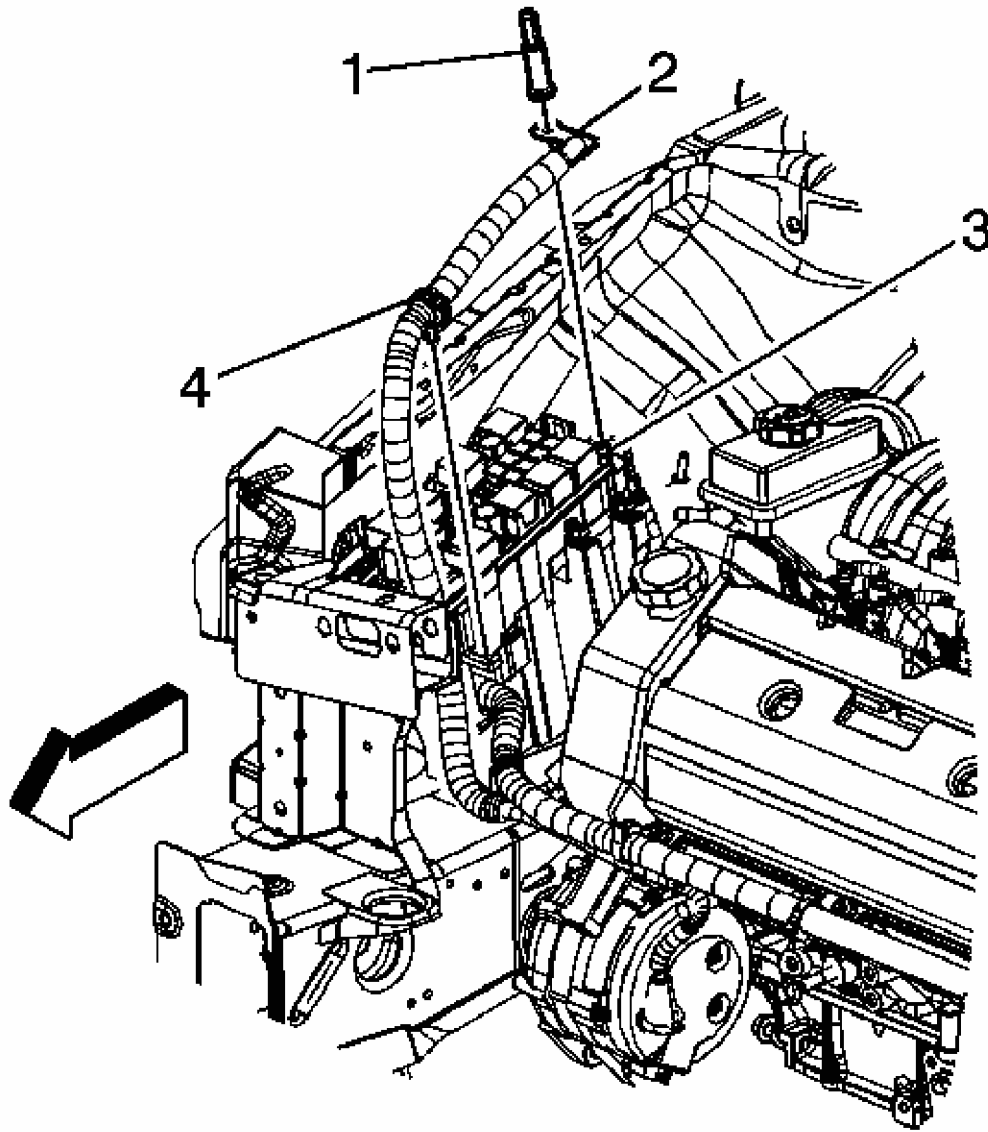


Fig. 37: Identifying Starter Solenoid Cable To Bussed Electrical Center
Courtesy of GENERAL MOTORS CORP.

11. Remove the nut (1) securing the starter cable to the bussed electrical center (BEC).
12. Remove the starter cable clip (4) from the BEC.
13. Remove the starter cable from the BEC terminal and secure to the top of the engine.

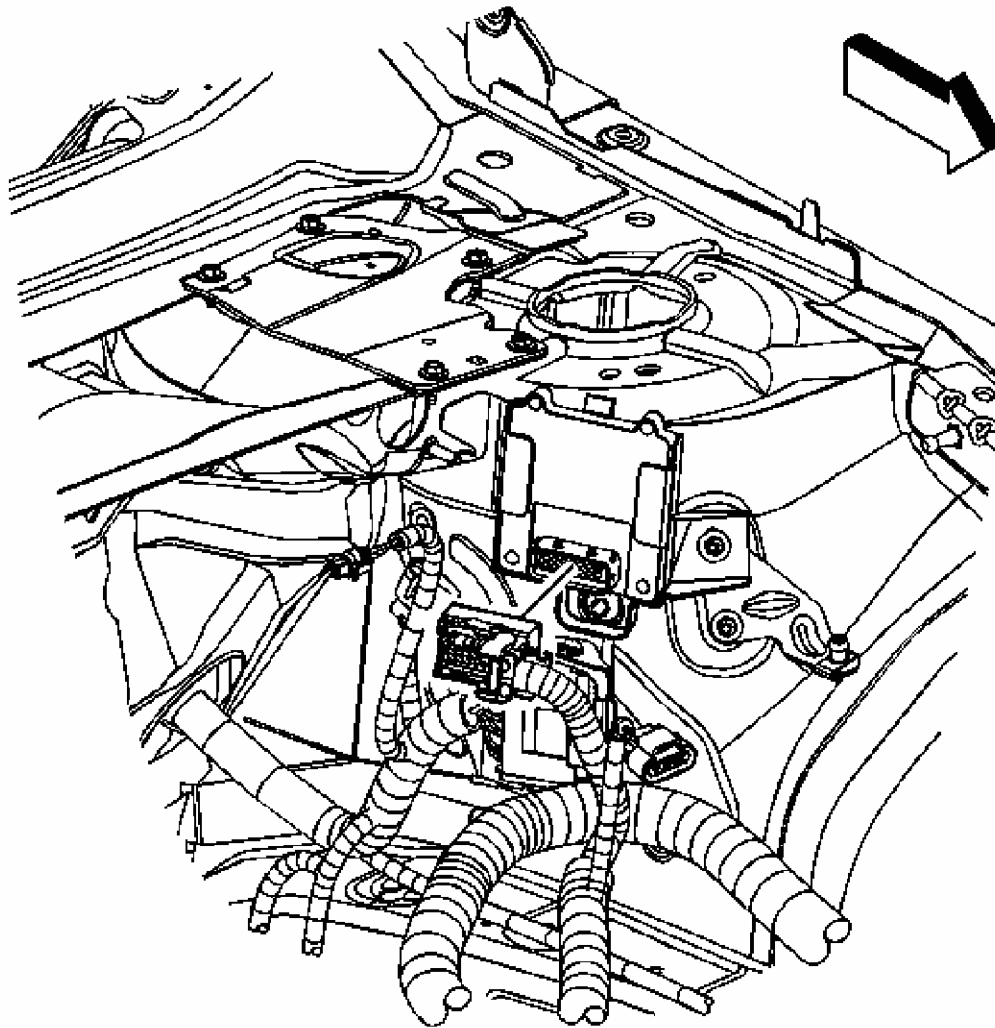


Fig. 38: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

14. Disengage the lever lock.
15. Disconnect the engine harness electrical connector from the transaxle control module (TCM).

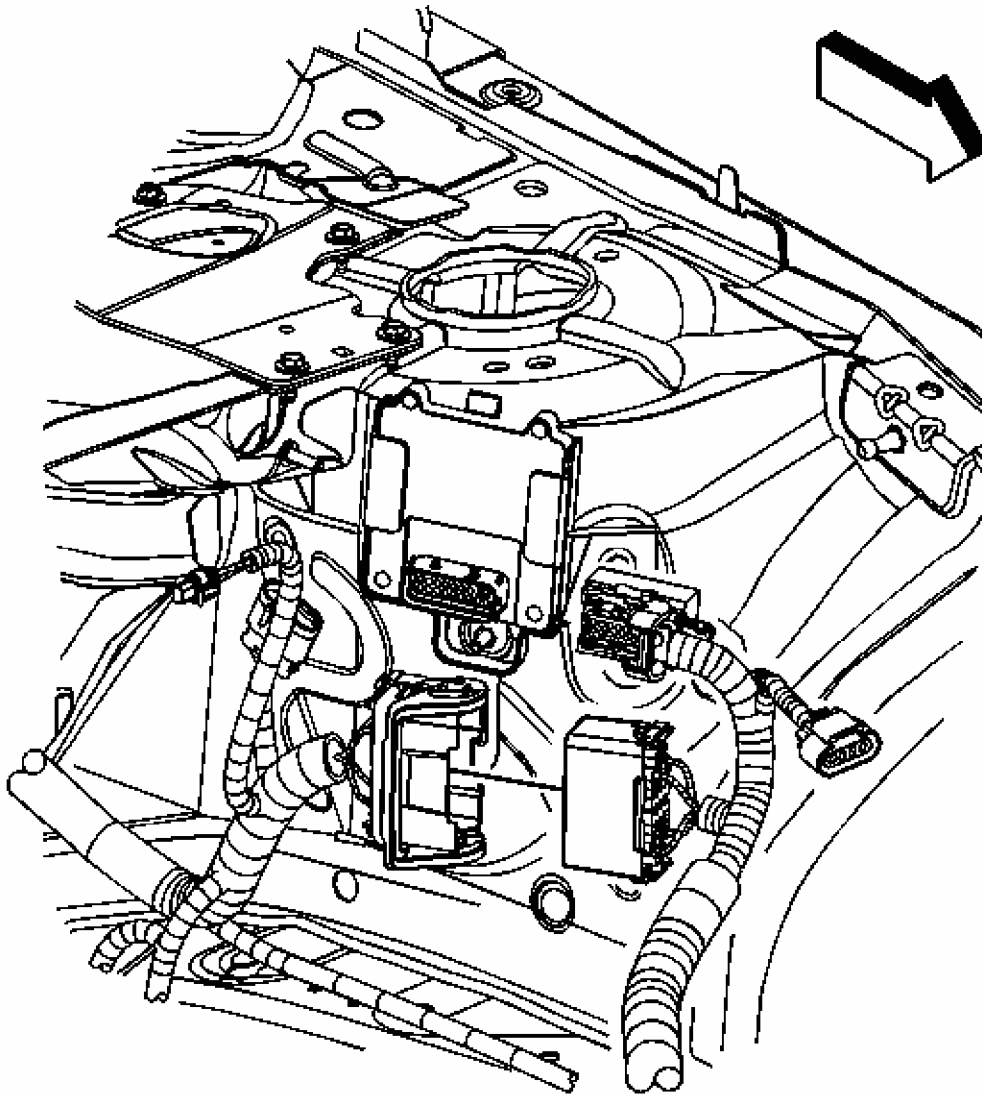


Fig. 39: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

16. Disengage the lever lock.
17. Disconnect the engine harness electrical connector from the body harness electrical connector.
18. Secure the TCM and engine harness wiring branches to the engine.

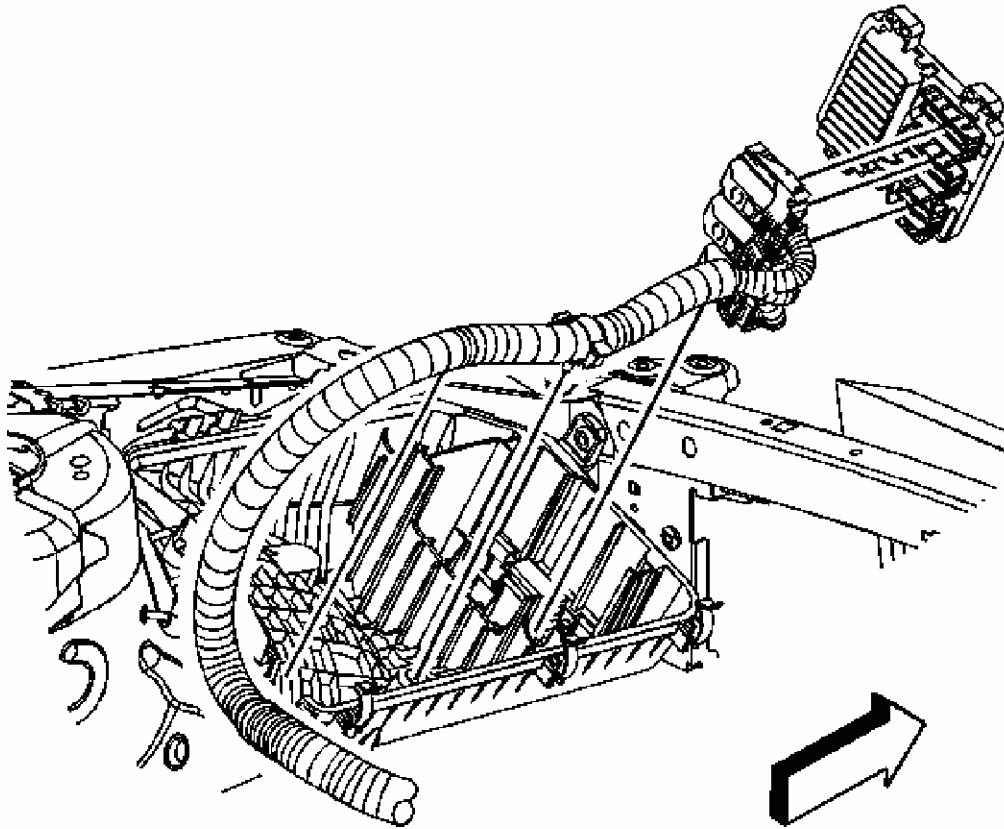


Fig. 40: Identifying Air Cleaner Lower Housing
Courtesy of GENERAL MOTORS CORP.

19. Disengage the lever locks.
20. Disconnect the engine harness electrical connectors from the engine control module (ECM).

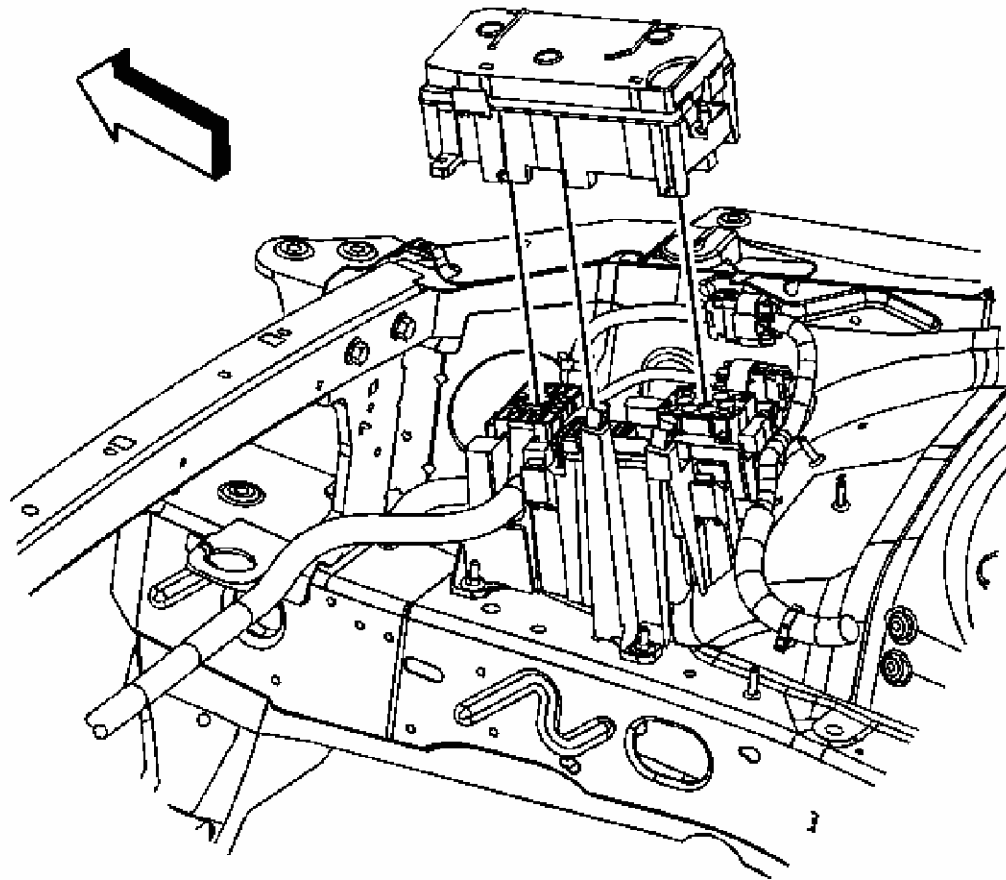


Fig. 41: Locating Junction Block
Courtesy of GENERAL MOTORS CORP.

21. Remove the junction block bolts.
22. Remove the junction block.

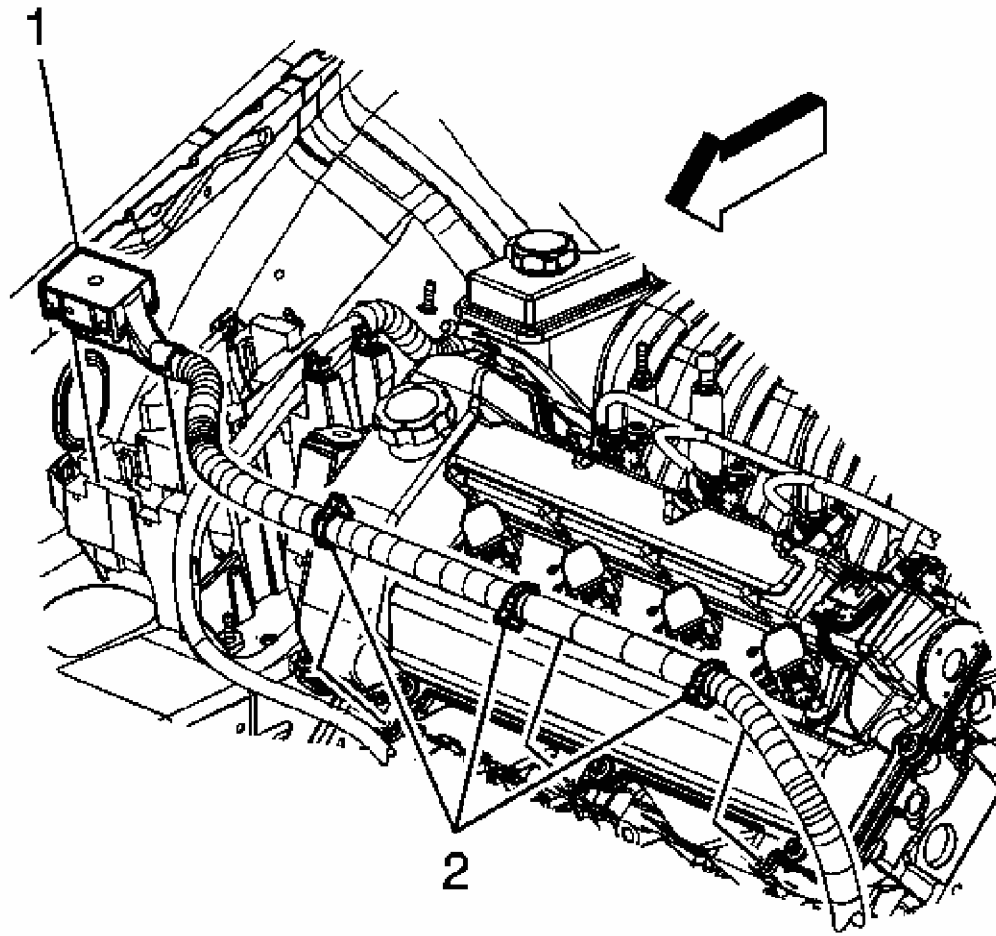


Fig. 42: View Of Engine Harness & Clips
Courtesy of GENERAL MOTORS CORP.

23. Remove the engine harness (1) from the BEC.

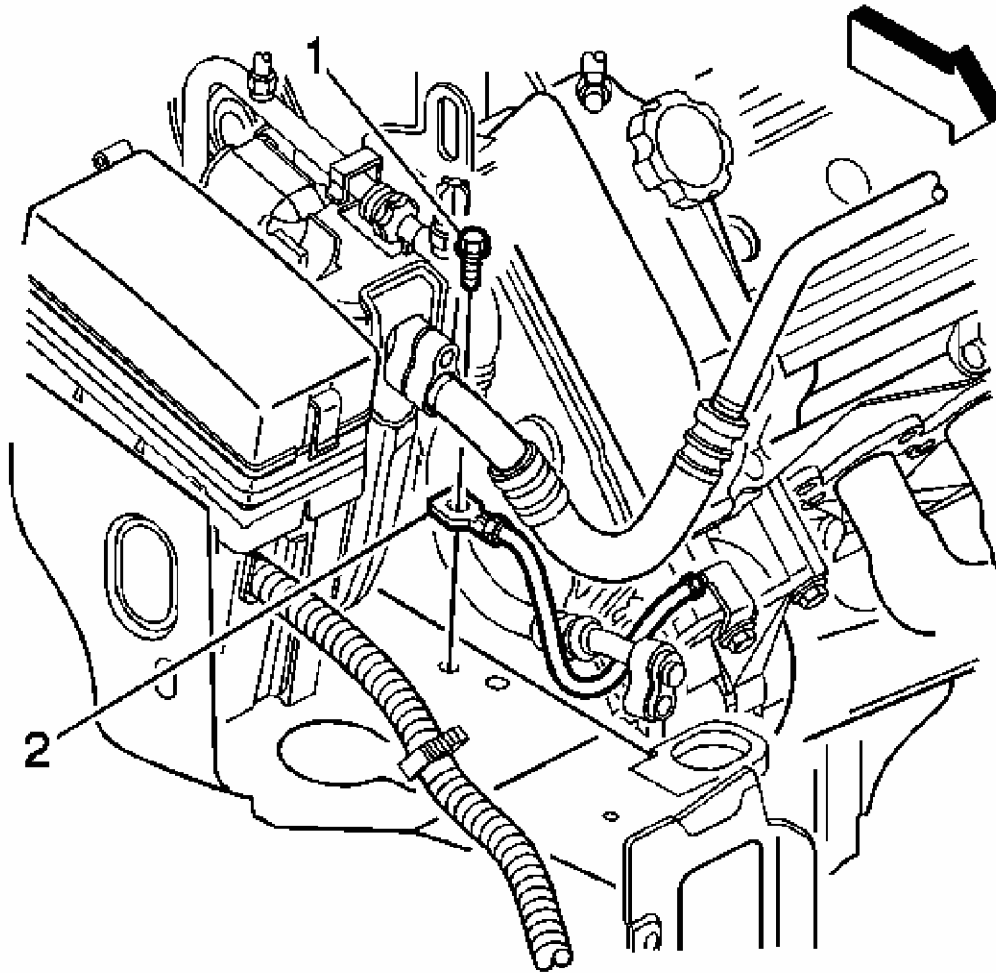


Fig. 43: Identifying Engine Ground Cable
Courtesy of GENERAL MOTORS CORP.

24. Remove the engine ground strap bolt (1) from the right side frame rail.
25. Secure the ground strap to the engine.

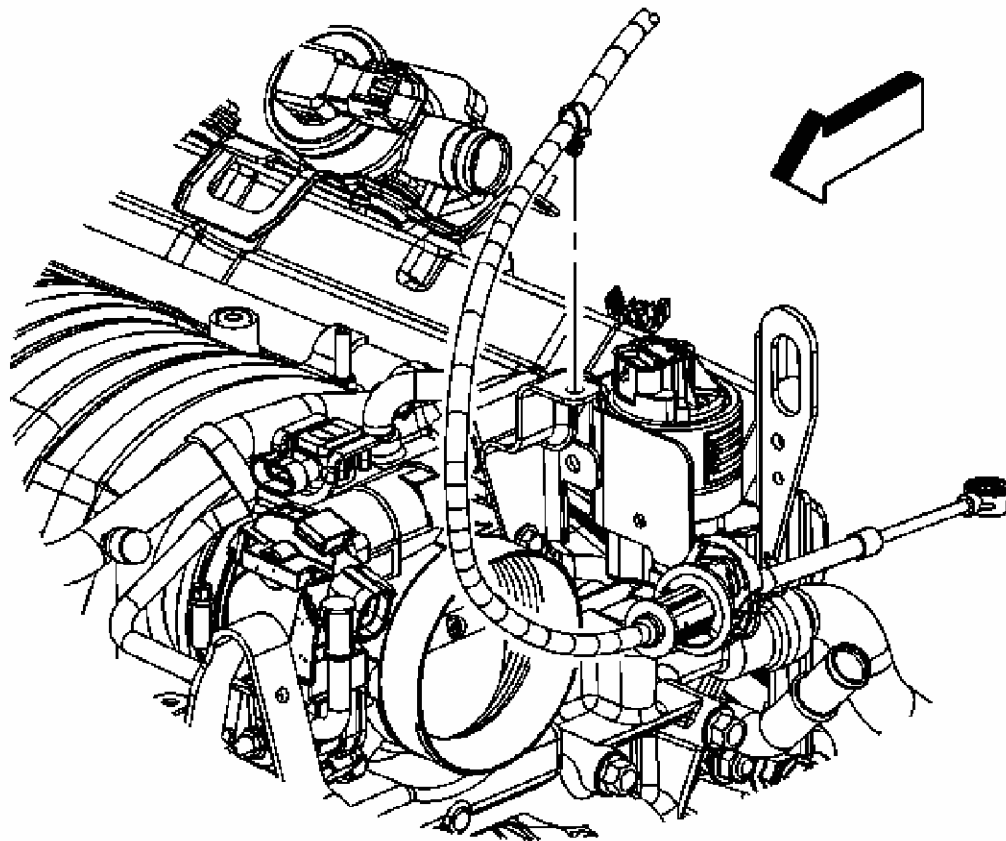


Fig. 44: Identifying Transaxle Shift Cable
Courtesy of GENERAL MOTORS CORP.

26. Remove the transaxle shift cable clip from the shift cable bracket.

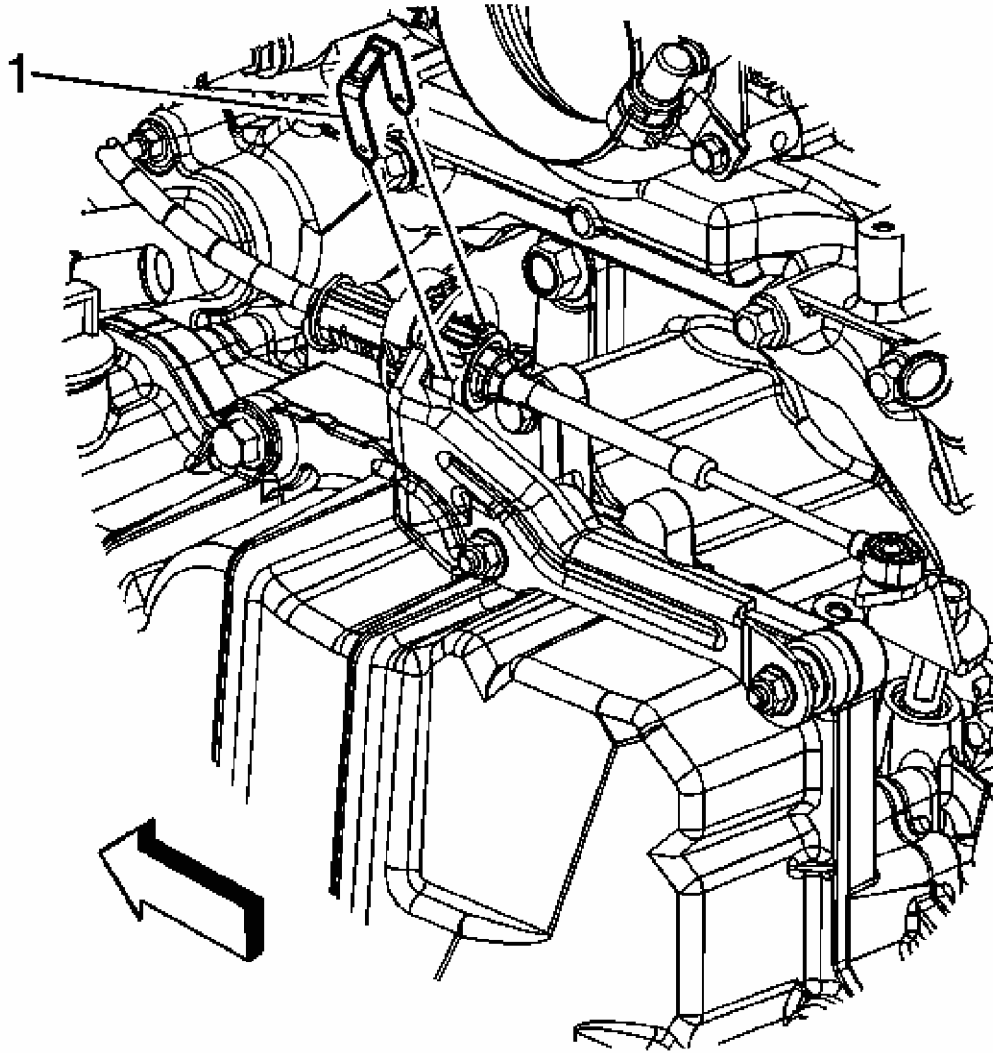


Fig. 45: Identifying Transaxle Shift Cable Retainer
Courtesy of GENERAL MOTORS CORP.

27. Remove the transaxle shift cable retainer (1).

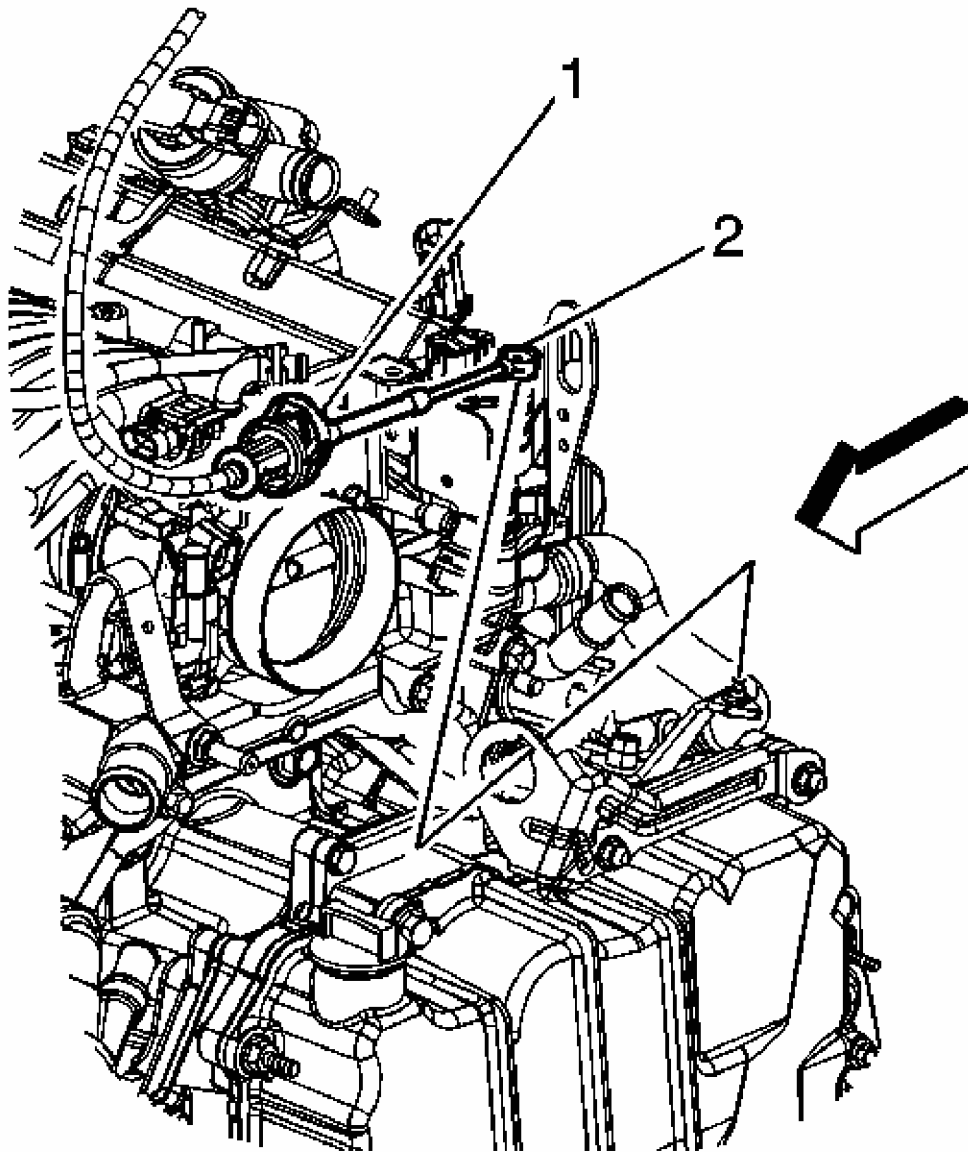


Fig. 46: View Of Transaxle Shift Cable
Courtesy of GENERAL MOTORS CORP.

28. Disconnect the transaxle shift cable end (2) from the range selector lever (1).
29. Remove the transaxle shift cable from the bracket and position the cable aside.
30. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .

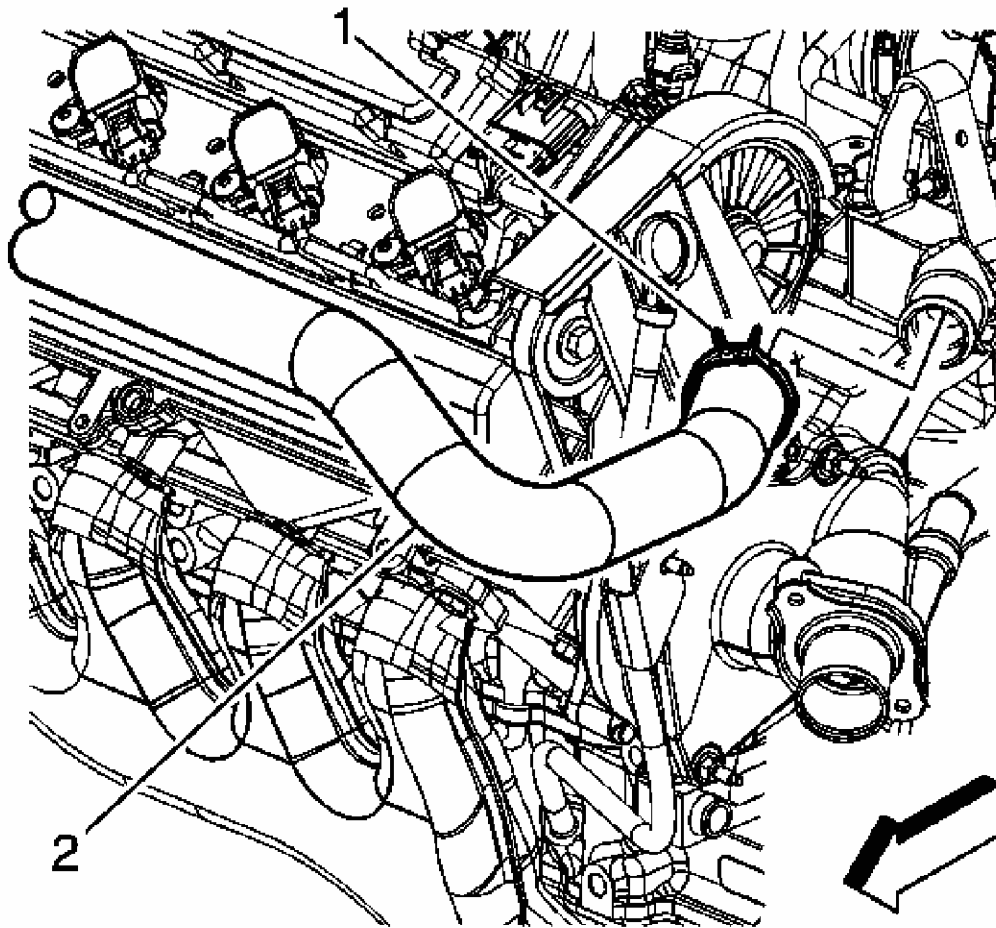


Fig. 47: View Of Radiator Inlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

31. Using the **J 37097-A** reposition the radiator inlet hose clamp (1). See **Special Tools** .
32. Remove the radiator inlet hose (2) from the water pump housing and position aside.

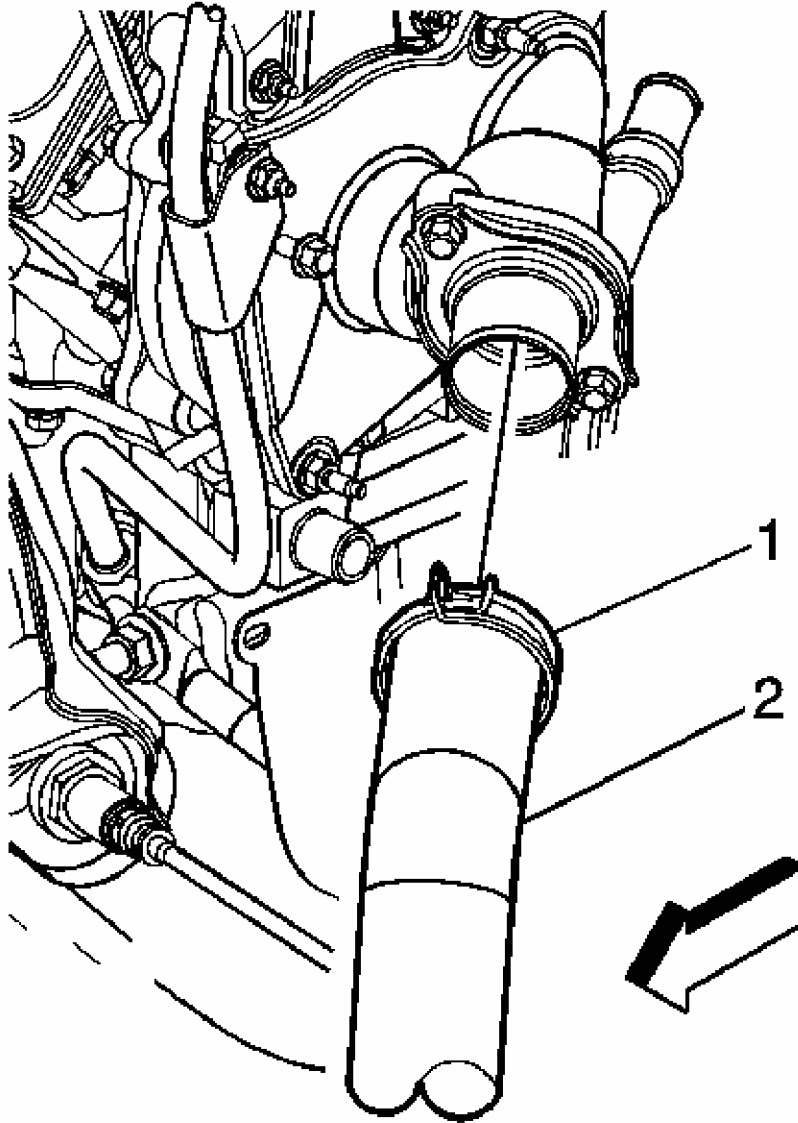


Fig. 48: View Of Radiator Outlet Hose At Thermostat Housing
Courtesy of GENERAL MOTORS CORP.

33. Using the **J 38185** reposition the radiator outlet hose clamp (1).
34. Remove the radiator outlet hose (2) from the thermostat housing and position aside.

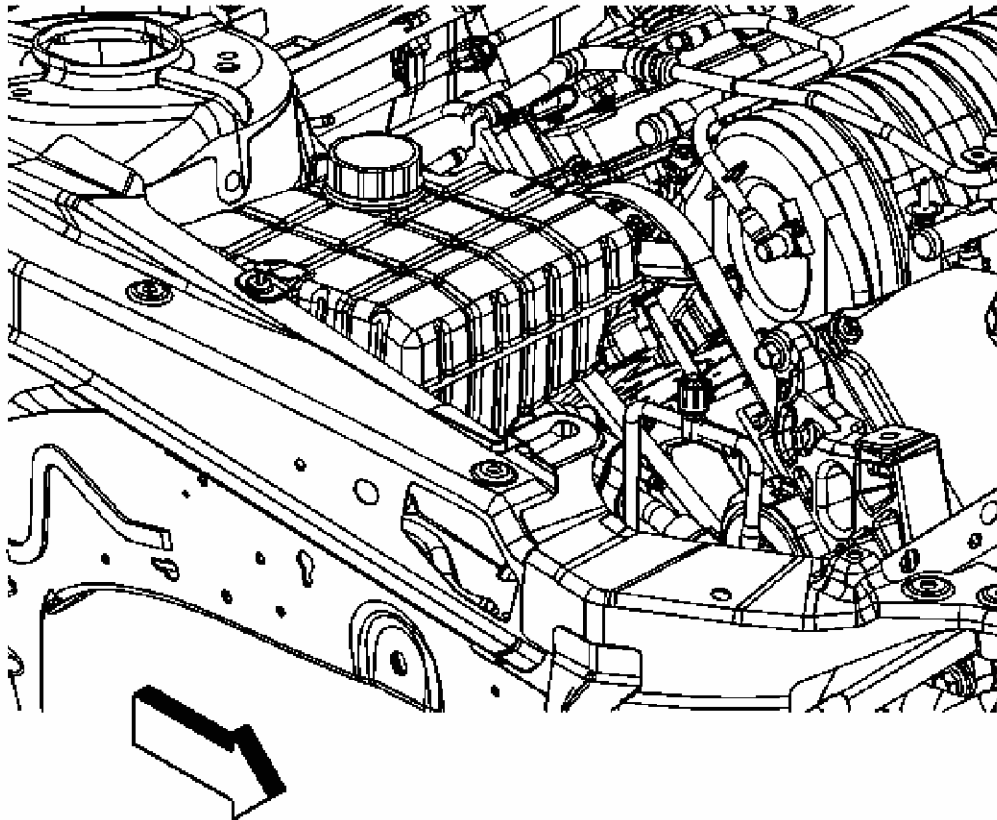


Fig. 49: Identifying Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS CORP.

35. Reposition the radiator surge tank inlet hose clamp at the surge tank.
36. Remove the surge tank inlet hose from the surge tank.

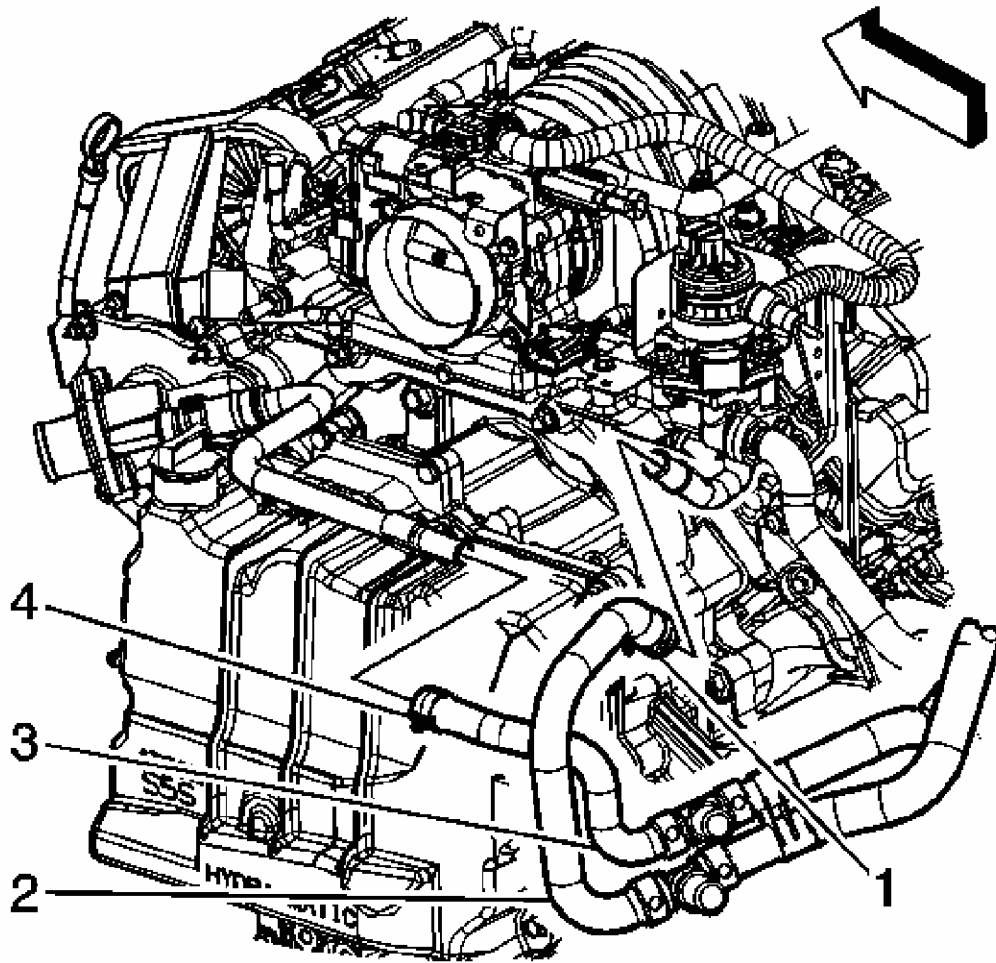


Fig. 50: Identifying Heater Inlet & Outlet Hoses
Courtesy of GENERAL MOTORS CORP.

37. Reposition the heater inlet (1) and outlet (2) hose clamps at the heater pipes.
38. Remove the heater inlet (2) and outlet (3) hoses from the heater pipes.

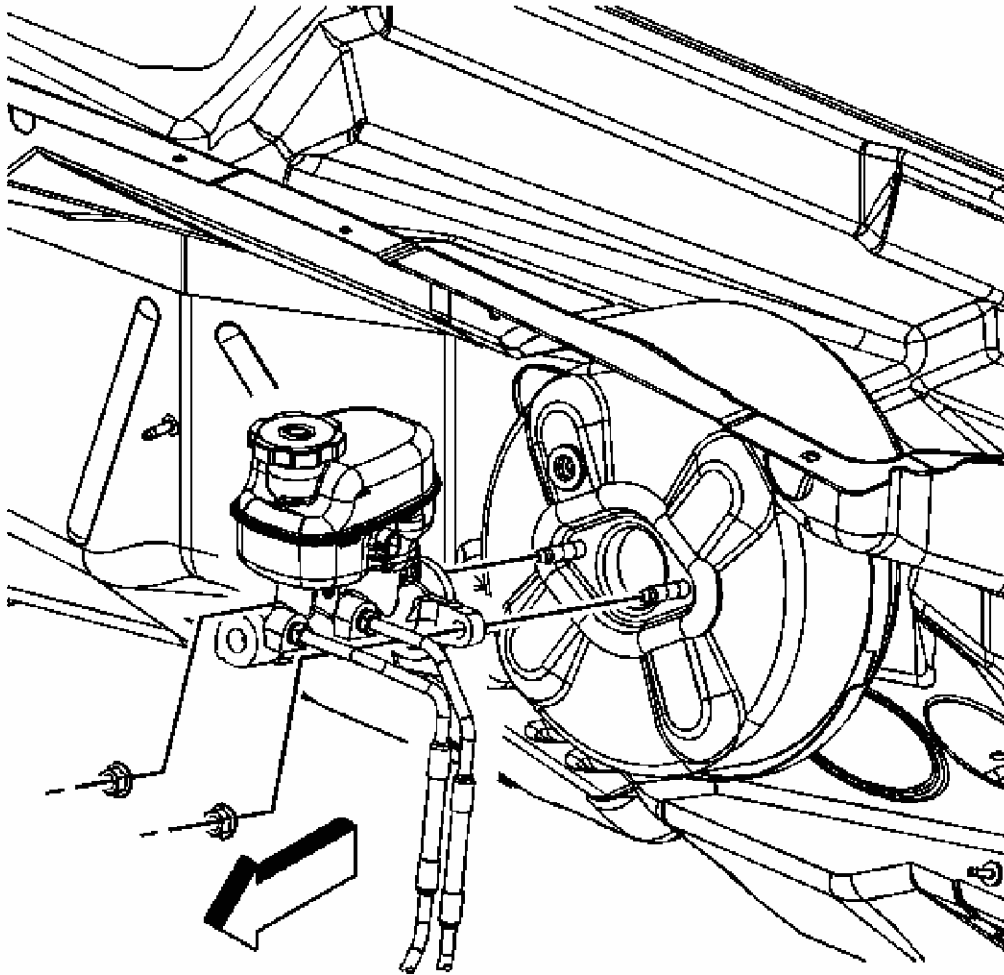


Fig. 51: View Of Master Cylinder & Brake Booster
Courtesy of GENERAL MOTORS CORP.

39. Remove the master cylinder nuts and master cylinder from the brake booster.
40. Reposition the master cylinder and secure the master cylinder to the engine.

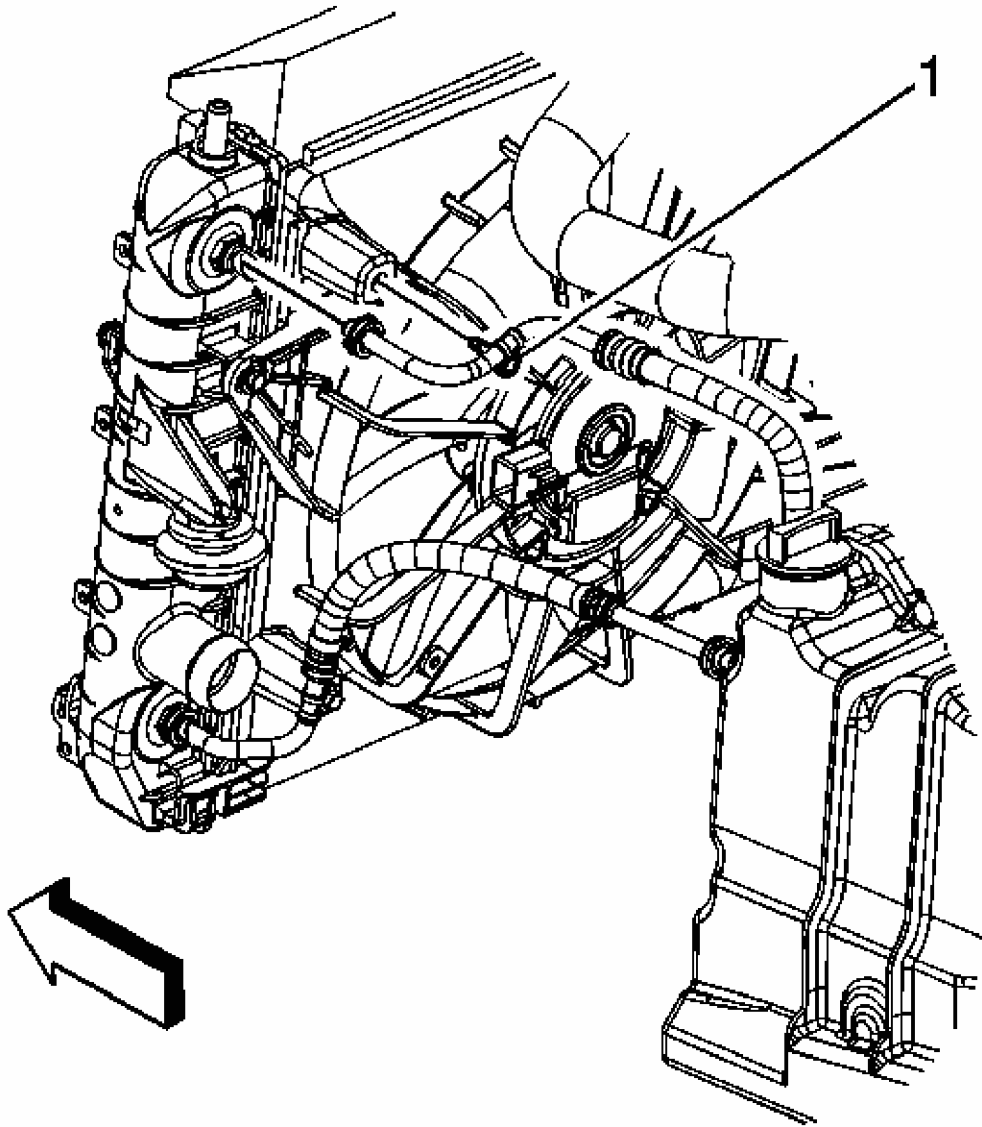


Fig. 52: Identifying Upper Transaxle Oil Cooler Pipe Bolt & Bolt
Courtesy of GENERAL MOTORS CORP.

41. Loosen the upper transaxle oil cooler pipe bolt (1) from the fan shroud.
42. Slide the plastic caps off the transaxle oil cooler pipe quick connect fittings.
43. Remove the right front engine mount strut bolt.
44. Disconnect the transaxle oil cooler pipes from the radiator using the **J 41623-B** . See **Special Tools** .

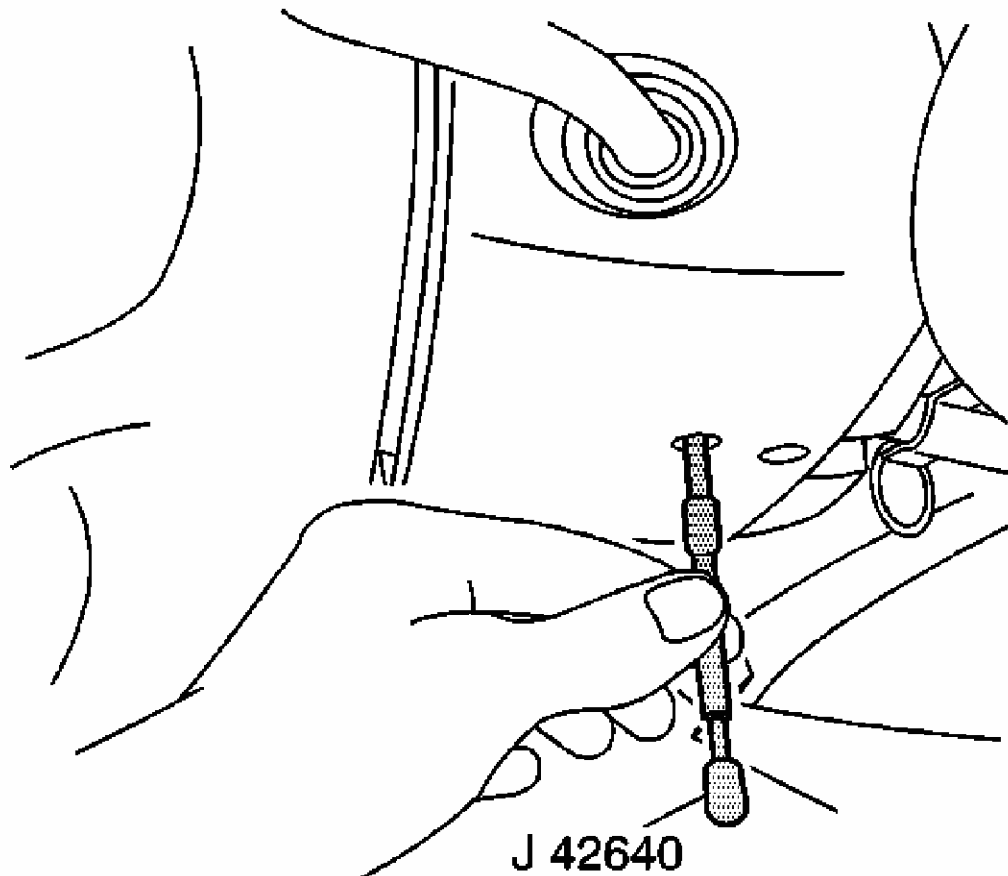


Fig. 53: Identifying J 42640

Courtesy of GENERAL MOTORS CORP.

NOTE: The wheels of the vehicle must be straight ahead and the steering column in the LOCK position before disconnecting the steering column or intermediate shaft from the steering gear. Failure to do so will cause the SIR coil assembly to become uncentered, which may cause damage to the coil assembly.

45. Lock the steering column by installing the **J 42640** into the underside of the steering column. See Special Tools .

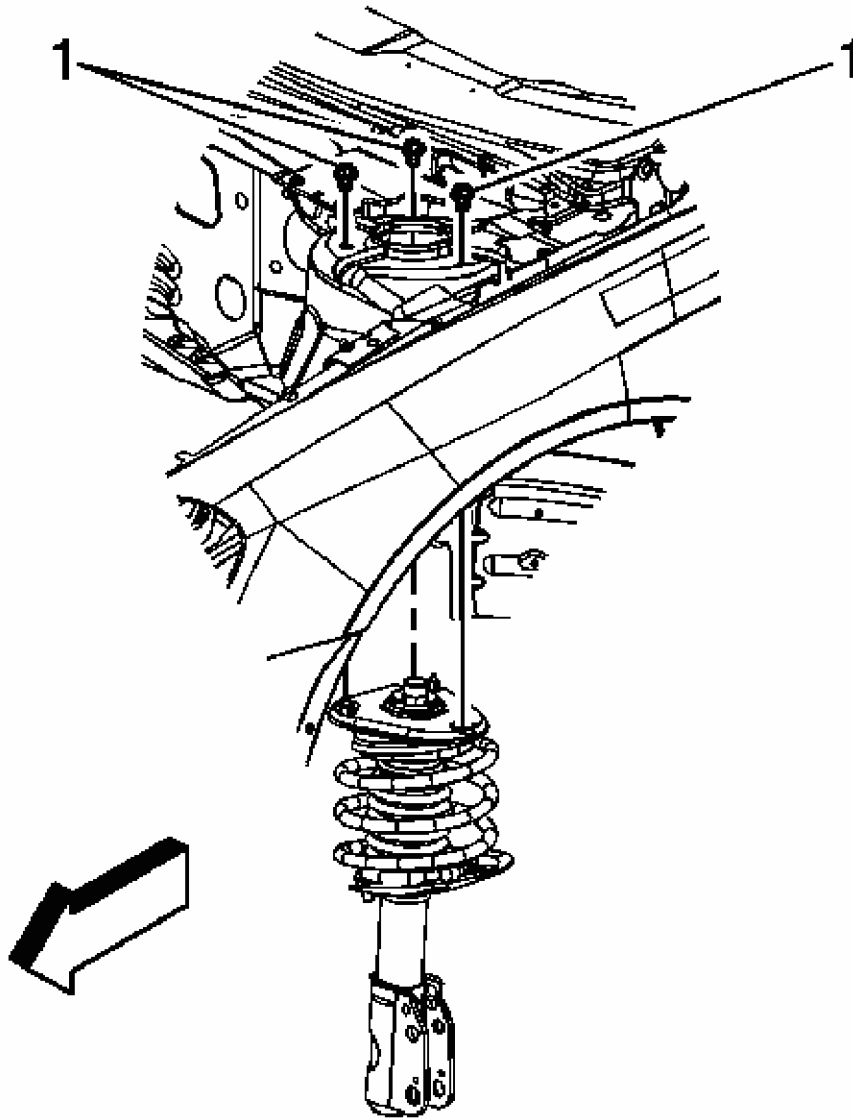


Fig. 54: Locating Strut Tower Bolts
Courtesy of GENERAL MOTORS CORP.

46. Remove the left and right side strut tower bolts (1). (Left side shown, right side similar.)
47. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
48. Remove the rear exhaust manifold pipe. Refer to **Exhaust Manifold Rear Pipe Replacement (RPO LD8)** .
49. Remove the front wheels. Refer to **Tire and Wheel Removal and Installation** .

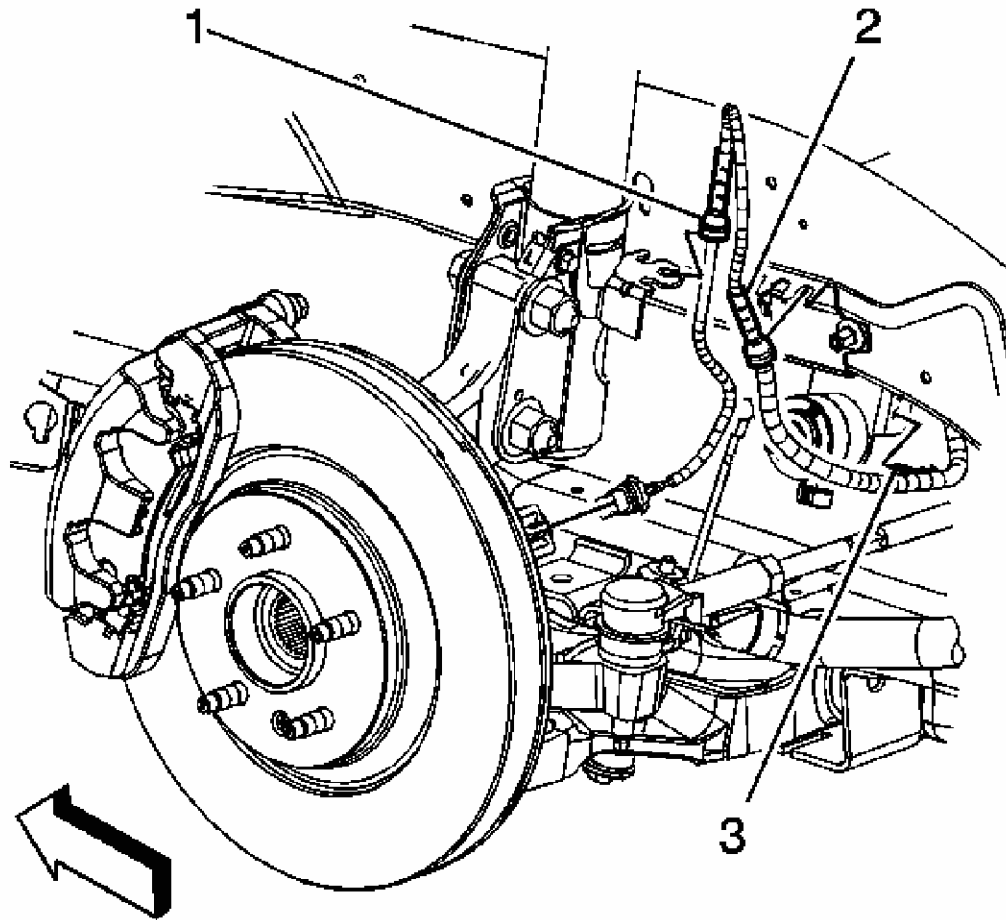


Fig. 55: Identifying Engine Harness Grommets & Clips
Courtesy of GENERAL MOTORS CORP.

- 50. Remove the engine harness grommet (2) from the frame rail bracket.
- 51. Remove the engine harness clip (3) from the ride lever sensor bracket.

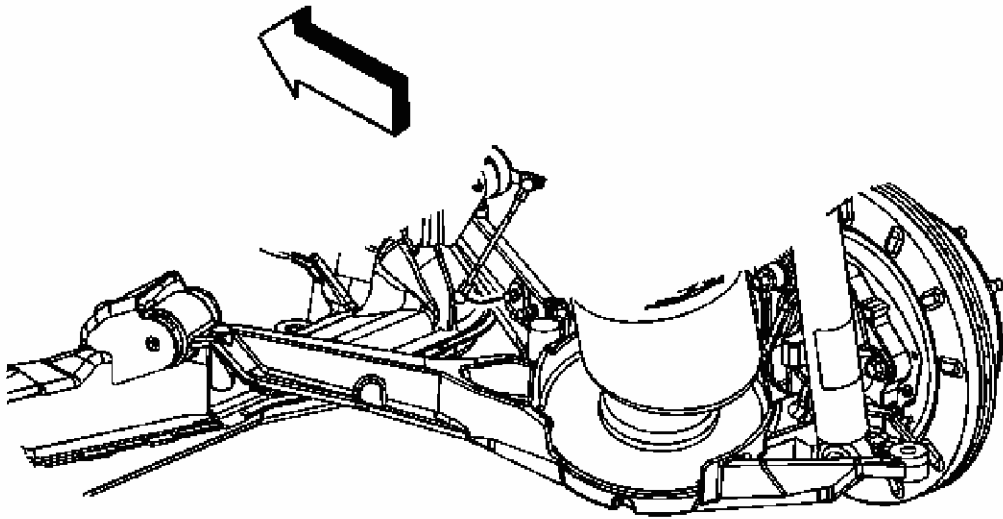


Fig. 56: Identifying Electronic Suspension Front Position Sensor Link
Courtesy of GENERAL MOTORS CORP.

52. Disconnect the electronic suspension front position sensor link from the lower control arms ball stud, if equipped.

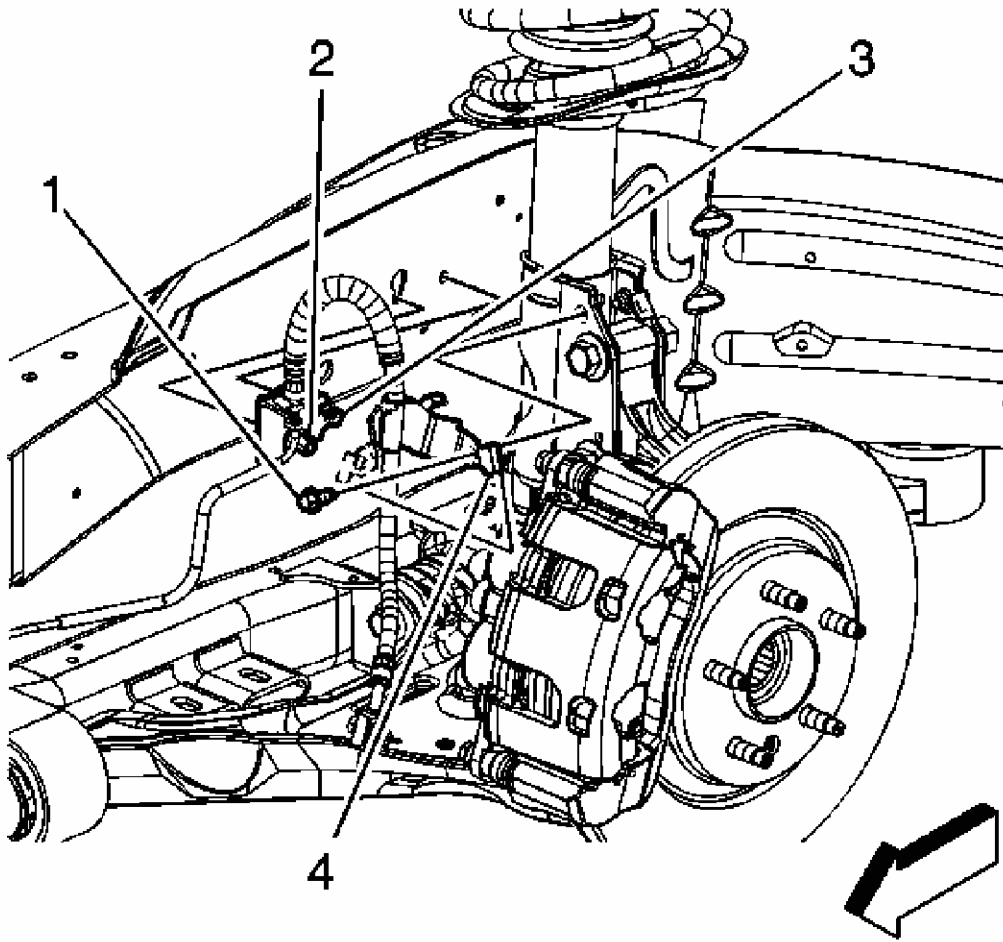


Fig. 57: Identifying Front Brake Pipe Bracket
Courtesy of GENERAL MOTORS CORP.

53. Loosen the nut (2) securing the left front brake pipe bracket (4) to the body frame rail.
54. Remove the front brake pipe bracket (4) from the body frame rail.

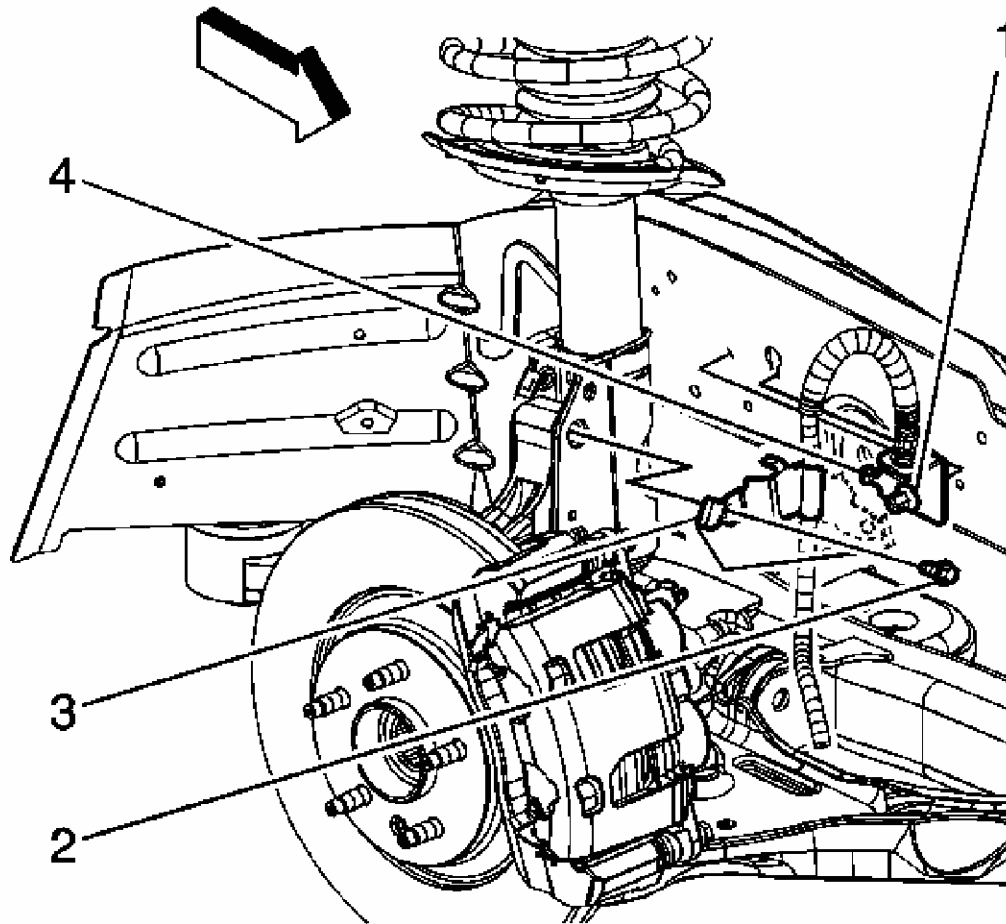


Fig. 58: Identifying Front Brake Pipe Bracket
Courtesy of GENERAL MOTORS CORP.

55. Loosen the nut (1) securing the right front brake pipe bracket (4) to the body frame rail.
56. Remove the front brake pipe bracket (4) from the body frame rail.

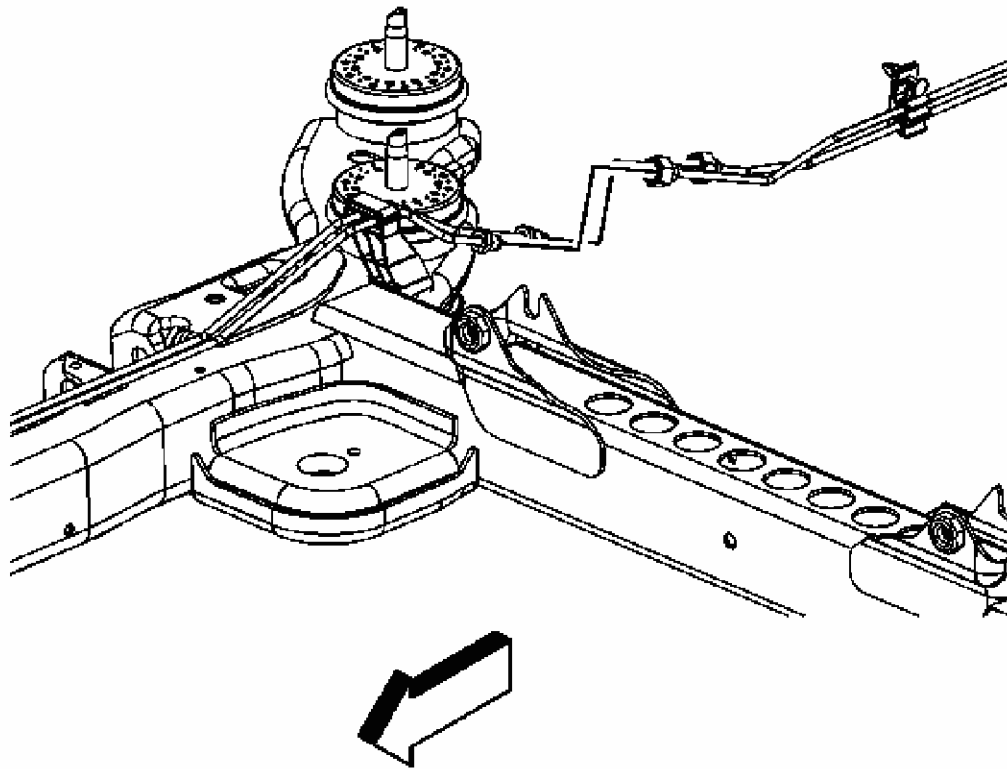


Fig. 59: Identifying Rear Brake Pipes/Lines
Courtesy of GENERAL MOTORS CORP.

57. Disconnect the rear brake pipes from the front brake pipes.
58. Plug the open brake lines in order to prevent fluid loss and/or system contamination.

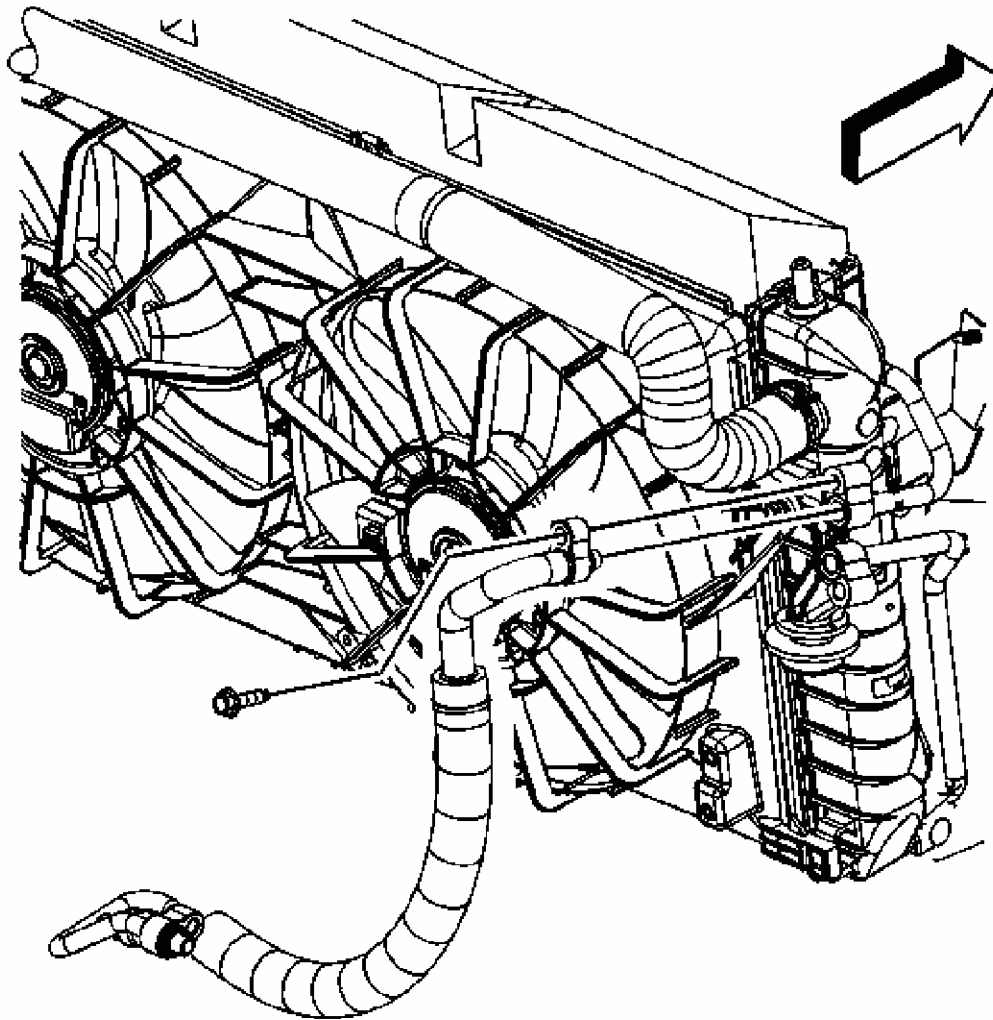


Fig. 60: View Of A/C Discharge Hose & Condenser
Courtesy of GENERAL MOTORS CORP.

59. Remove the A/C compressor discharge hose bolt at the condenser.
60. Remove the A/C compressor discharge hose from the condenser and secure to the engine.
61. Plug the A/C condenser discharge port.

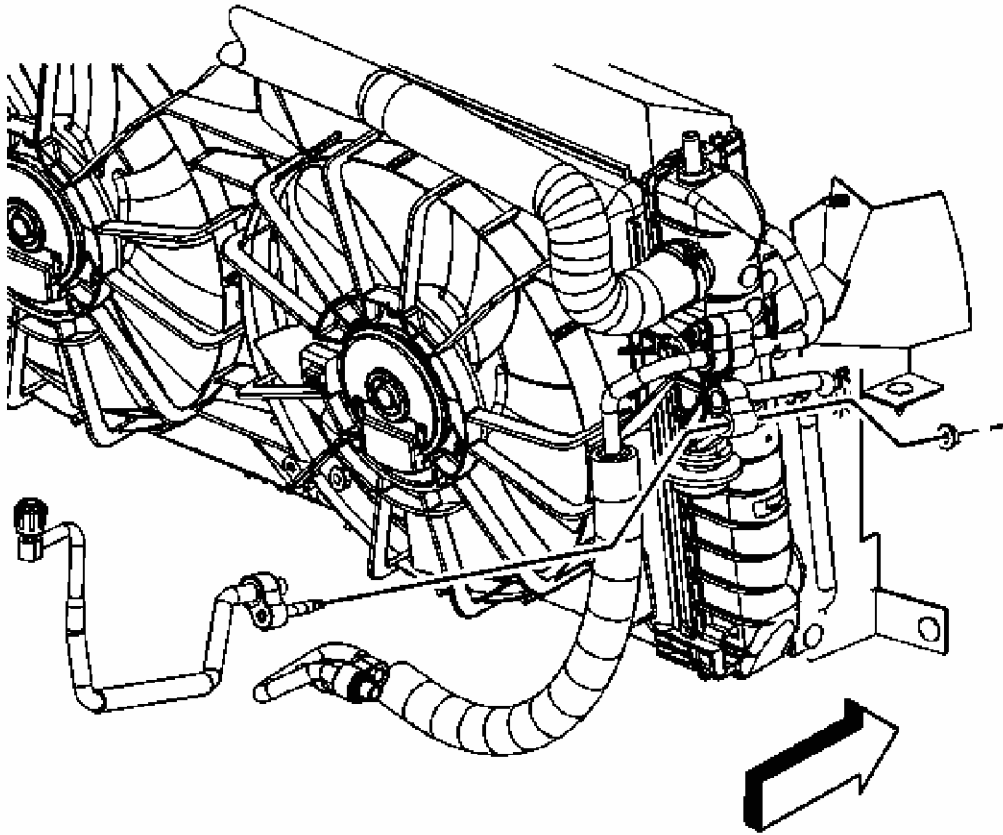


Fig. 61: View Of A/C Suction Hose & Condenser
Courtesy of GENERAL MOTORS CORP.

62. Remove the A/C compressor suction hose nut at the condenser.
63. Remove the A/C compressor suction hose from the condenser and secure to the engine.
64. Plug the A/C condenser suction port.

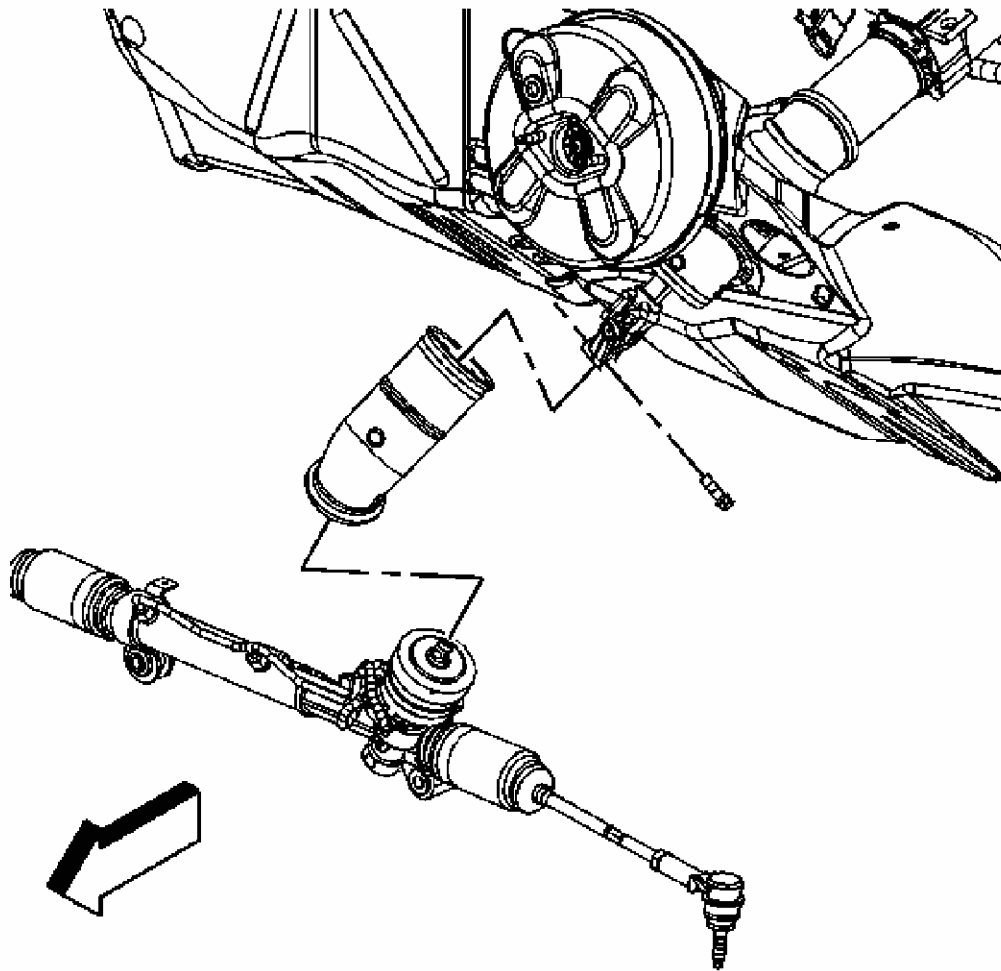


Fig. 62: Identifying Steering Gear & Related Attachments
Courtesy of GENERAL MOTORS CORP.

CAUTION: Failure to disconnect the intermediate shaft from the rack and pinion stub shaft can result in damage to the steering gear and/or damage to the intermediate shaft. This damage may cause loss of steering control which could result in personal injury.

65. Remove the intermediate steering shaft cover.
66. Remove the intermediate shaft pinch bolt.
67. Remove the intermediate shaft from the steering gear.

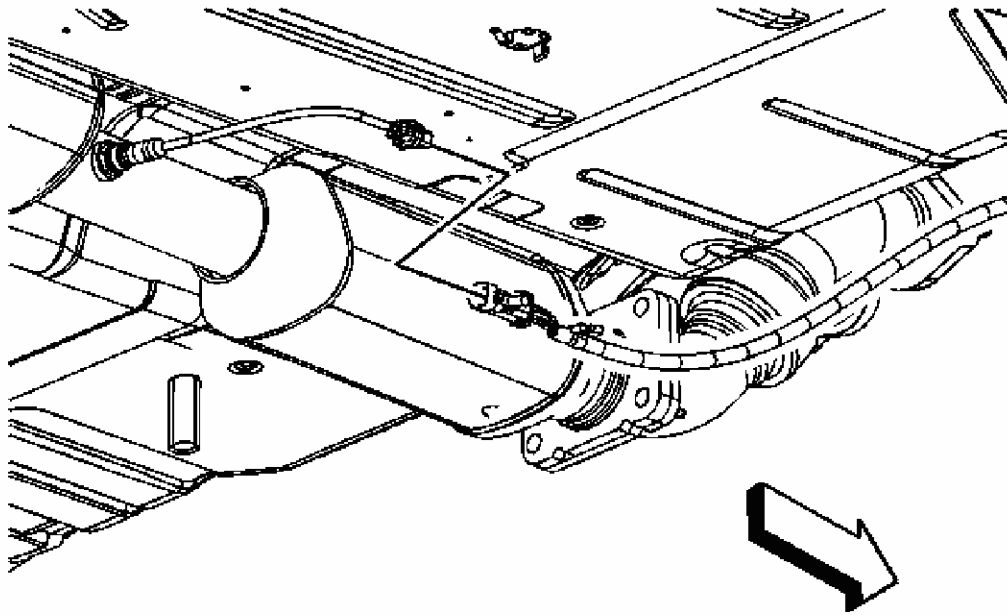


Fig. 63: Identifying Oxygen Sensor Wiring Harness Heat Shield
Courtesy of GENERAL MOTORS CORP.

68. Remove the oxygen sensor wiring harness heat shield. Refer to **Oxygen Sensor Wiring Harness Heat Shield Replacement** .
69. Disconnect the engine harness electrical connector from the heated oxygen sensor (HO2S).

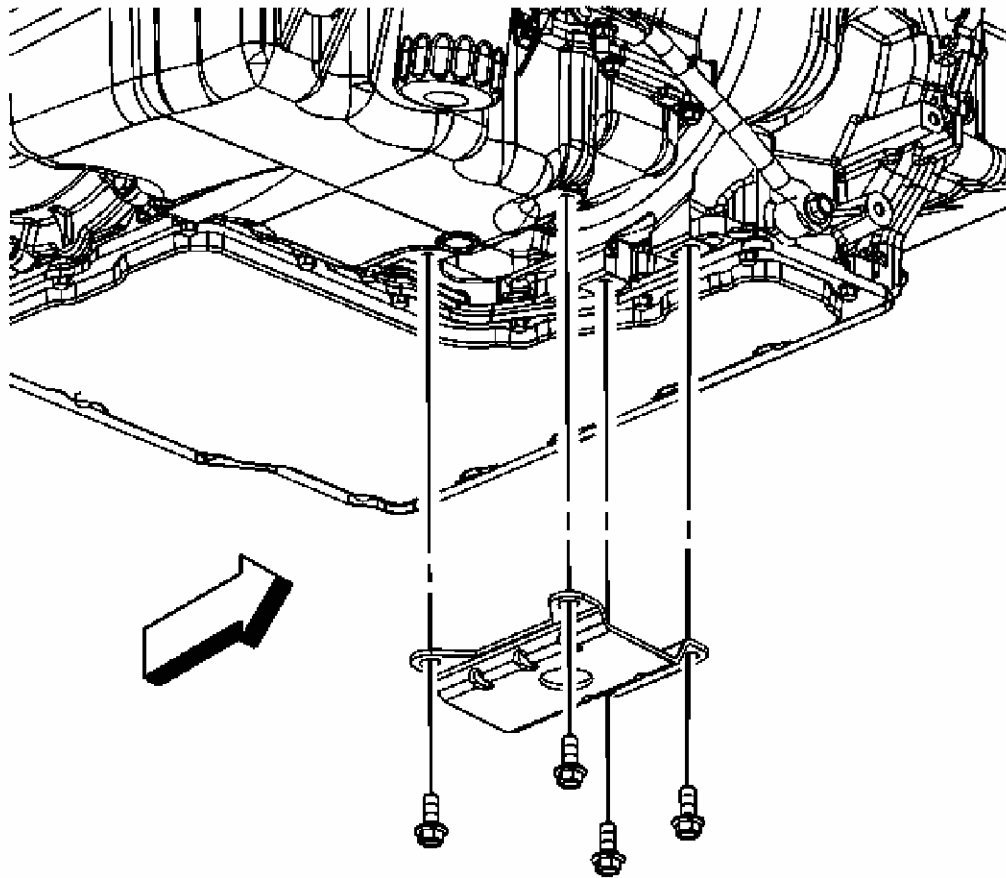


Fig. 64: Identifying Transaxle To Engine Brace Bolts
Courtesy of GENERAL MOTORS CORP.

70. Remove the transaxle brace bolts.
71. Remove the transaxle brace.

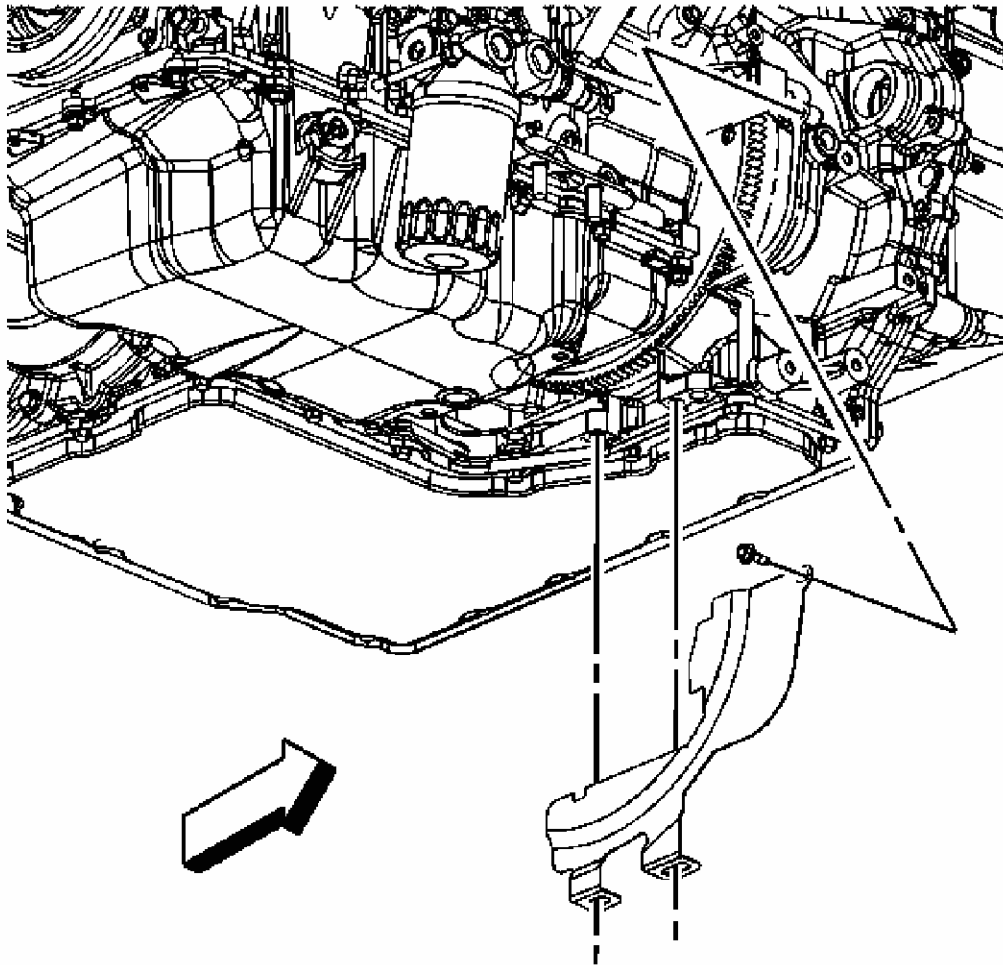


Fig. 65: View Of Torque Converter Cover
Courtesy of GENERAL MOTORS CORP.

72. Remove the torque converter cover bolt.
73. Remove the torque converter cover.

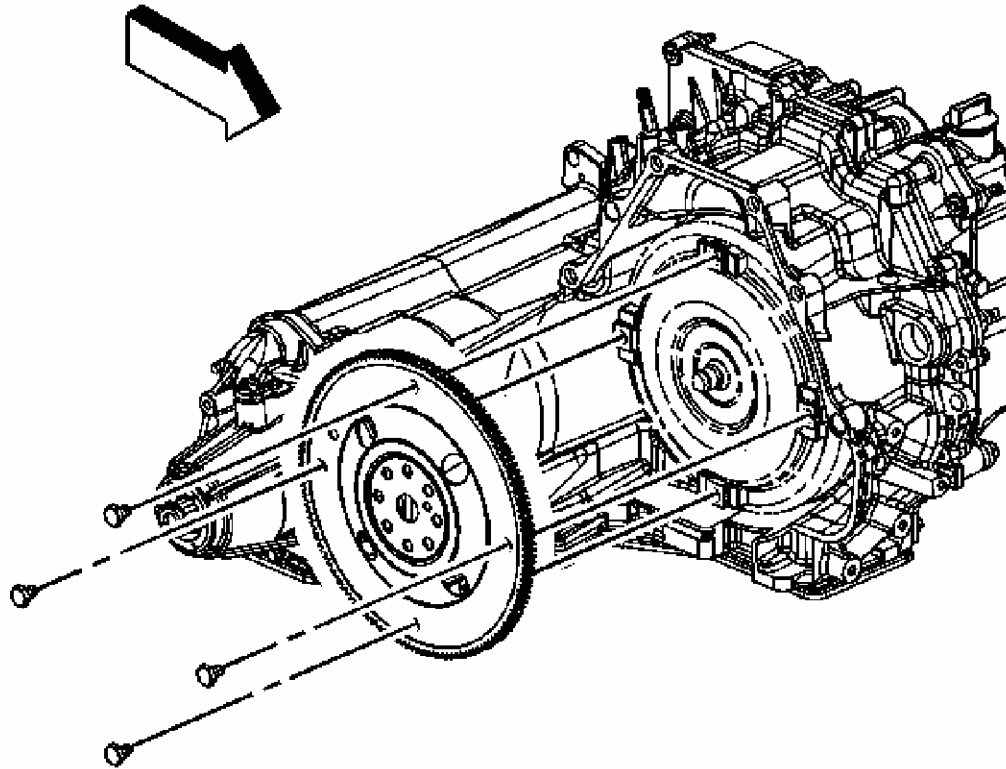


Fig. 66: Identifying Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Mark the flywheel to torque converter relationship prior to removal of the bolts.

74. Remove the flywheel to torque converter bolts. (Engine removed for clarity).

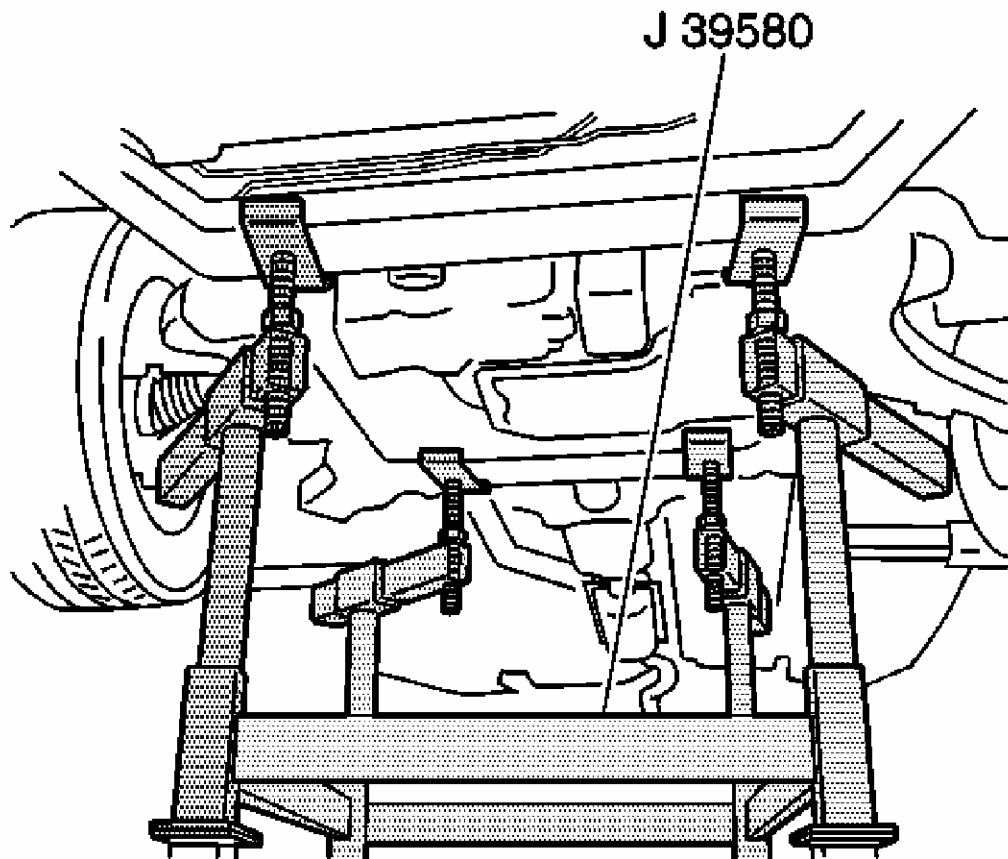


Fig. 67: Identifying Utility Stand
Courtesy of GENERAL MOTORS CORP.

75. Position the **J 39580** under the frame. See **Special Tools** .
76. Lower the vehicle onto the **J 39580** . See **Special Tools** .

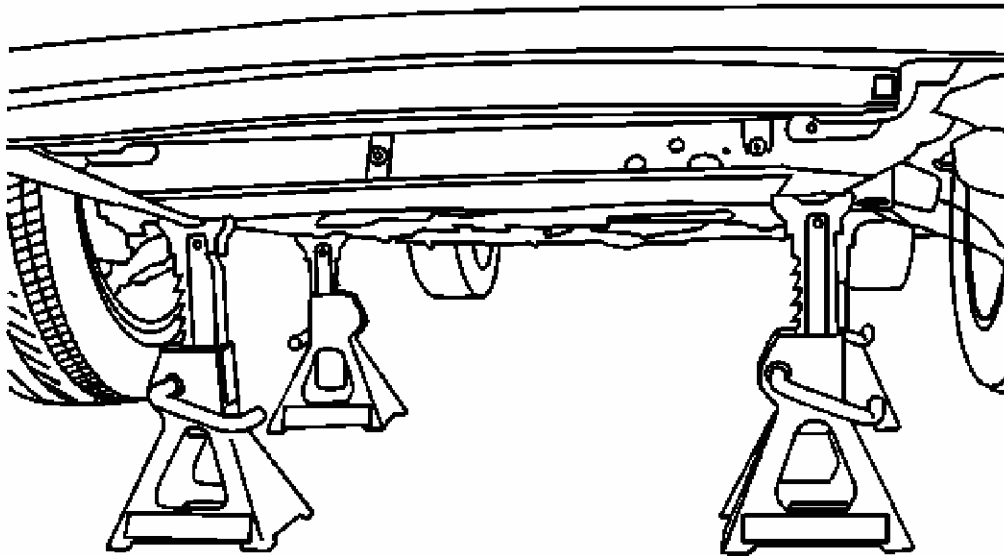


Fig. 68: Locating Jackstands Under Engine Frame
Courtesy of GENERAL MOTORS CORP.

77. If the **J 39580** is not available. See **Special Tools** . Support the powertrain with four suitable jackstands.
78. Place a 2 in x 4 in block of wood between the front of the engine oil pan and the engine frame.

CAUTION: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

79. Secure the front hoist pads to the vehicle.
80. Remove the front fascia. Refer to **Front Bumper Fascia Replacement** .

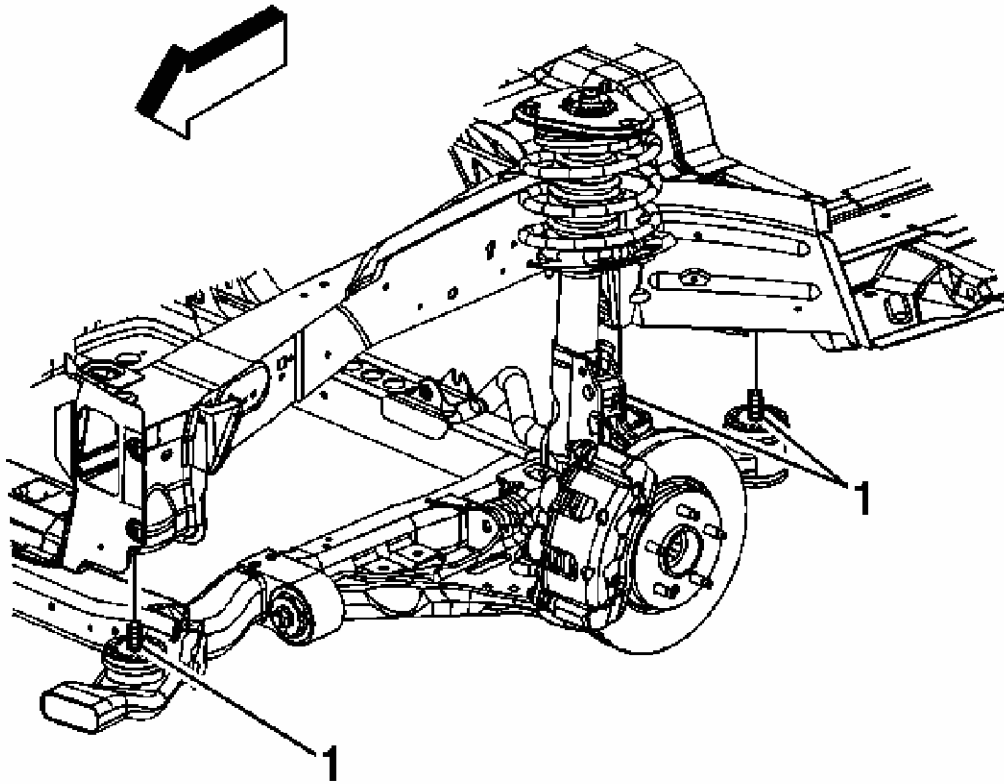


Fig. 69: Identifying Rearward Engine Frame-To-Body Bolts
Courtesy of GENERAL MOTORS CORP.

81. Remove the 6 bolts (1) attaching the frame to the body. (Left side shown, right side similar).

IMPORTANT: Ensure clearance is maintained between the engine/transaxle assembly and the following:

- The A/C compressor components
- The brake pipes
- The heater hoses
- The radiator hoses
- The wheel speed sensor leads
- The wiring harnesses

82. Carefully raise the vehicle in order to clear the supported engine/transaxle assembly.

83. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

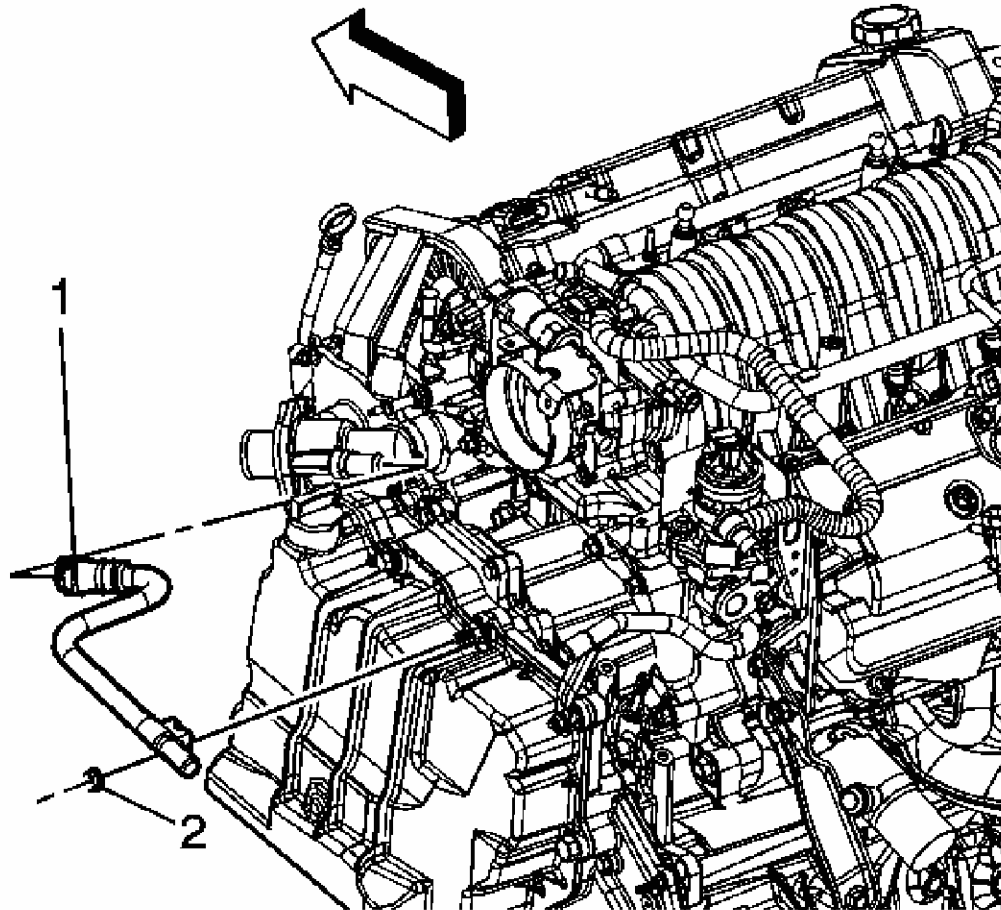


Fig. 70: Identifying Heater Outlet Pipe
Courtesy of GENERAL MOTORS CORP.

- 84. Remove the heater outlet pipe nut (2) from the transaxle stud.
- 85. Reposition the heater outlet pipe clamp (1) at the water pump housing.
- 86. Remove the heater outlet pipe.

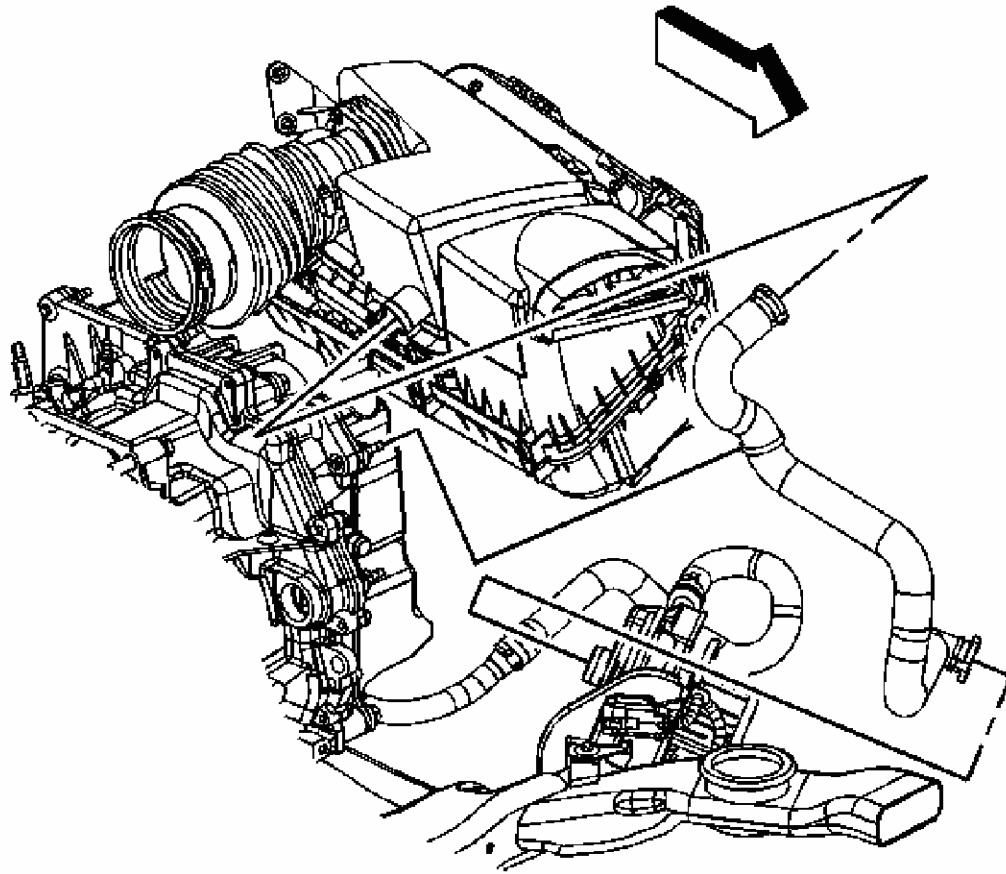


Fig. 71: Identifying Secondary AIR Pump Inlet Tube/Hose
Courtesy of GENERAL MOTORS CORP.

87. Remove the secondary air injection (AIR) inlet hose retainer from the transaxle stud.
88. Disconnect the AIR inlet hose quick connect fitting from the AIR pump. Refer to **Plastic Collar Quick Connect Fitting Service**.
89. Remove the AIR inlet hose.

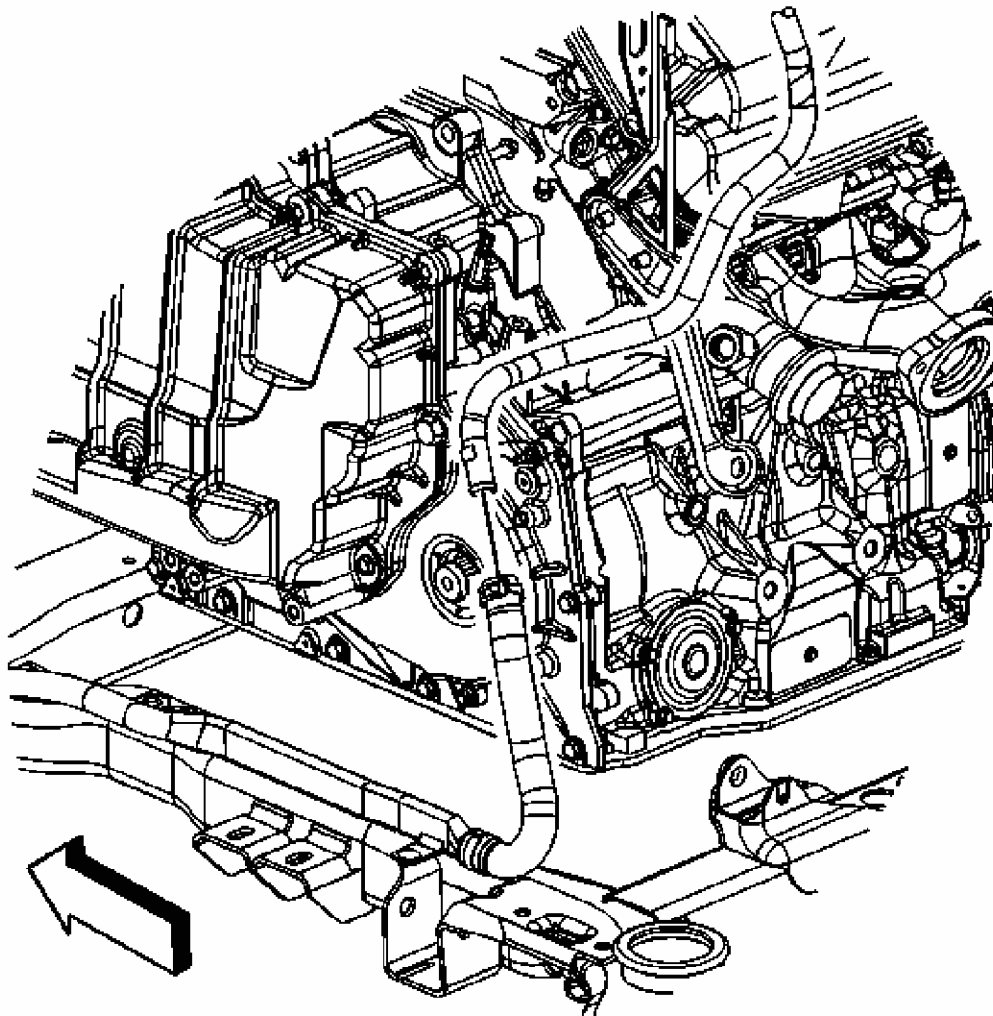


Fig. 72: View Of AIR Outlet Hose
Courtesy of GENERAL MOTORS CORP.

90. Reposition the AIR outlet hose clamp at the AIR outlet pipe.
91. Separate the AIR outlet hose from the outlet pipe.

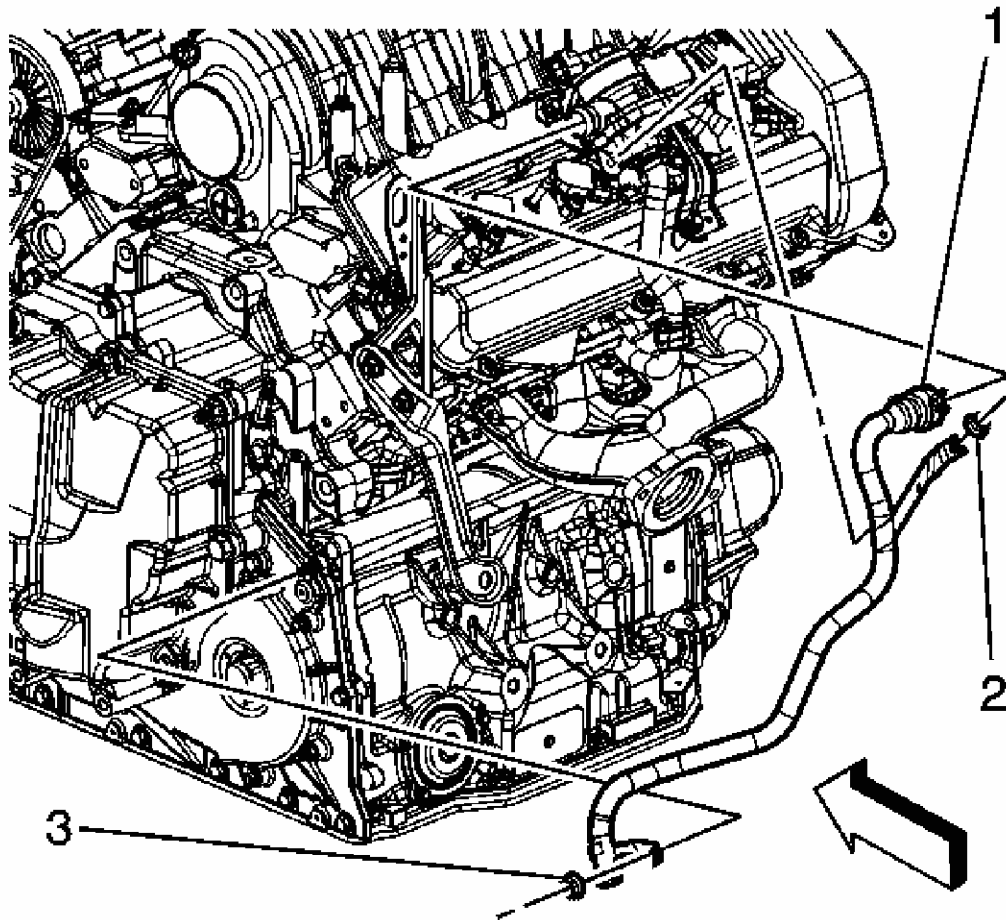


Fig. 73: View Of AIR Pipe Outlet Pipe
Courtesy of GENERAL MOTORS CORP.

92. Remove the AIR pipe outlet pipe nut (3) from the transaxle stud.
93. Remove the AIR pipe outlet pipe nut (2) from the check valve bracket stud.
94. Disconnect the AIR outlet pipe quick connect fitting from the check valve. Refer to **Plastic Collar Quick Connect Fitting Service** .
95. Remove the AIR outlet pipe from the studs.

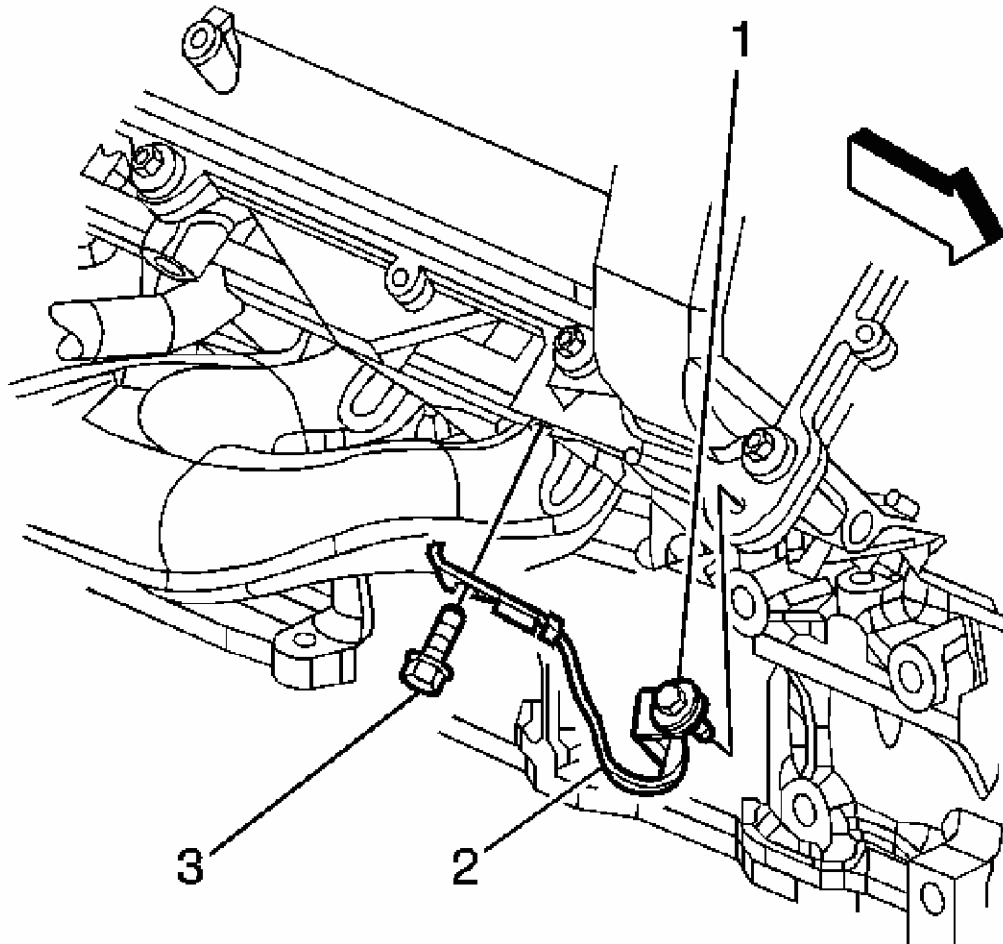


Fig. 74: Locating ICM Ground Strap & Bolt
Courtesy of GENERAL MOTORS CORP.

96. Remove the ignition control module (ICM) ground strap bolt (3) from the right cylinder head.
97. Remove the ICM ground strap (2) from the cylinder head.

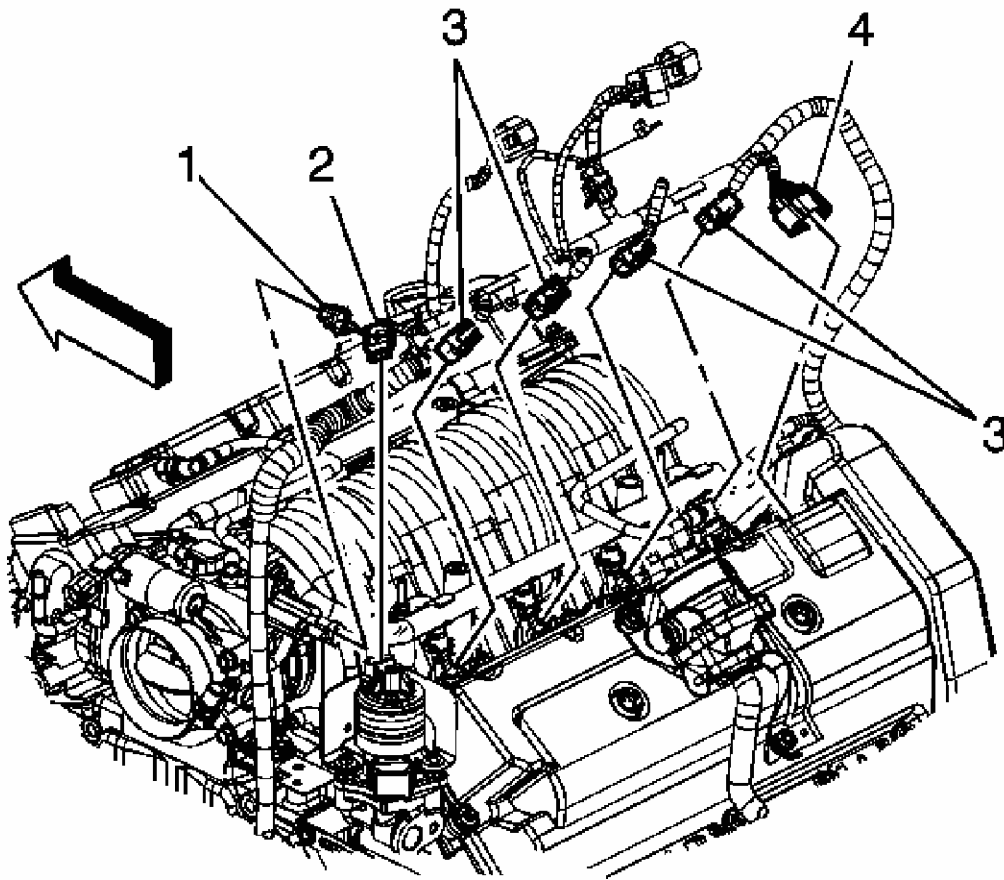


Fig. 75: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

98. Disconnect the following engine harness electrical connectors from the rear of the engine:
- The EVAP solenoid (1)
 - The exhaust gas recirculation (EGR) valve (2)
 - The fuel injectors (3)
 - The ICM (4)

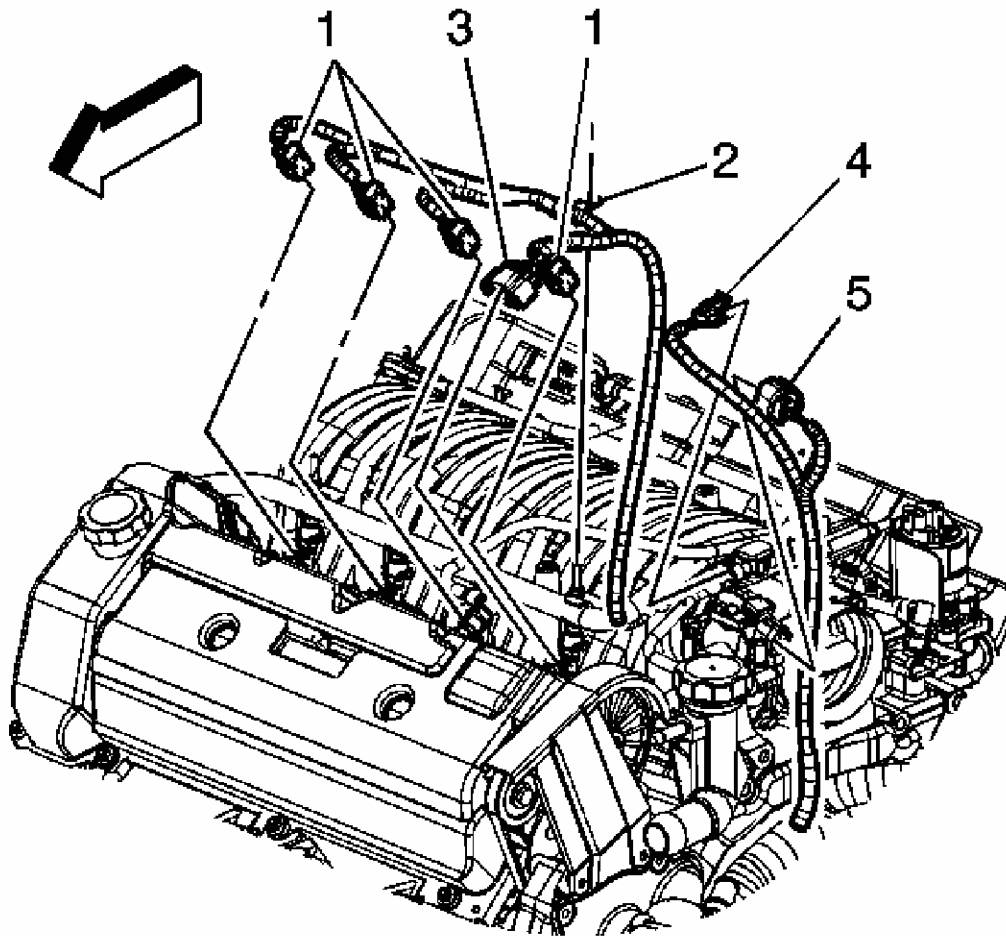


Fig. 76: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

99. Disconnect the following engine harness electrical connectors from the front of the engine:
 - The fuel injectors (1)
 - The ICM (3)
 - The manifold absolute pressure (MAP) sensor (4)
 - the throttle actuator (5)
100. Remove the engine harness clip (2) from the fuel rail stud.

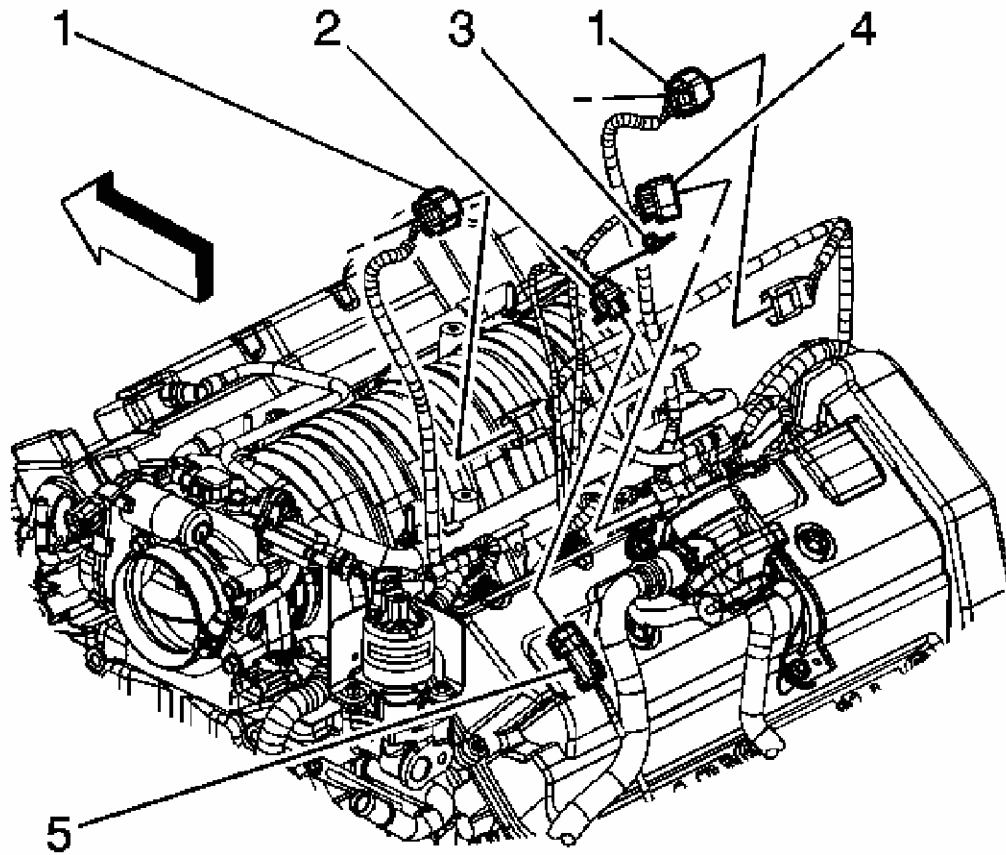


Fig. 77: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

101. Disconnect the following engine harness electrical connectors from the top of the engine:
- The starter inline (1)
 - The AIR check valve (4)

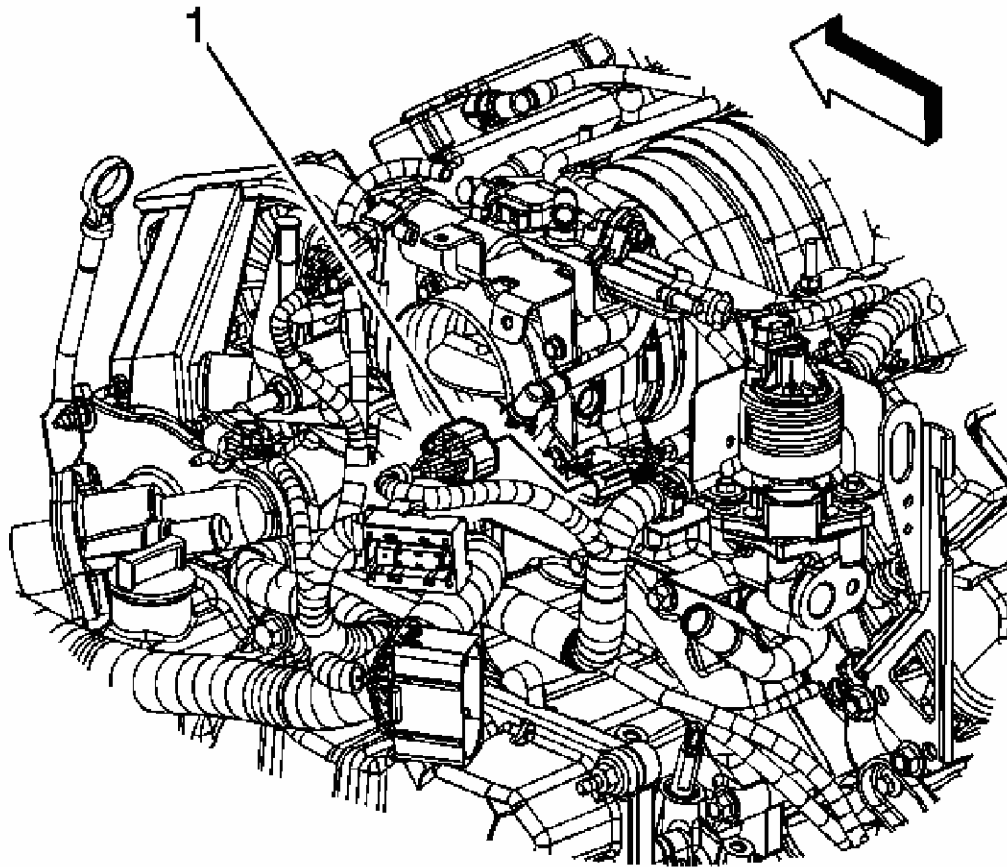


Fig. 78: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

102. Disconnect the engine harness electrical connector (1) from the engine valley jumper harness electrical connector.

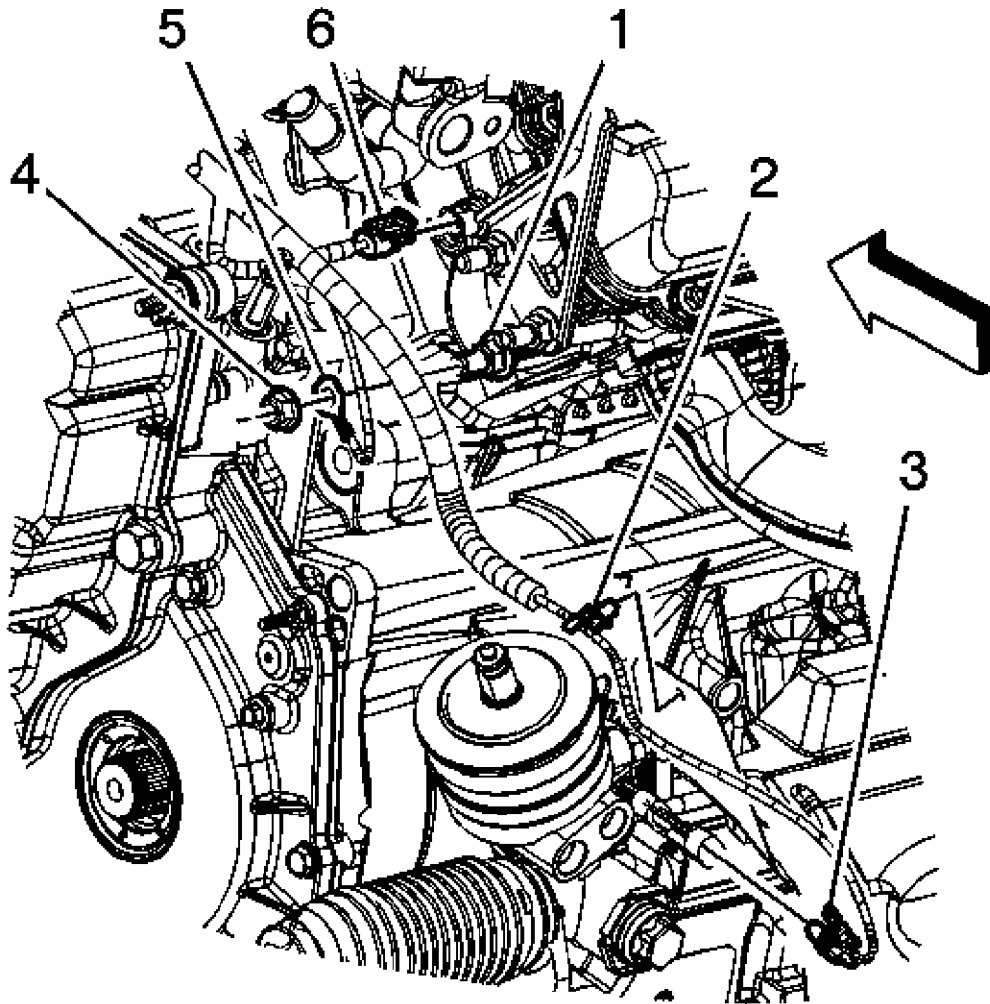


Fig. 79: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

- l03. Disconnect the engine harness electrical connector (3) from the power steering sensor.
- l04. Remove the engine harness clip (2) from the steering gear shield.
- l05. Remove the engine harness ground nut (4).
- l06. Remove the engine harness ground (5).
- l07. Disconnect the engine harness electrical connector (6) from the engine coolant temperature (ECT) sensor.

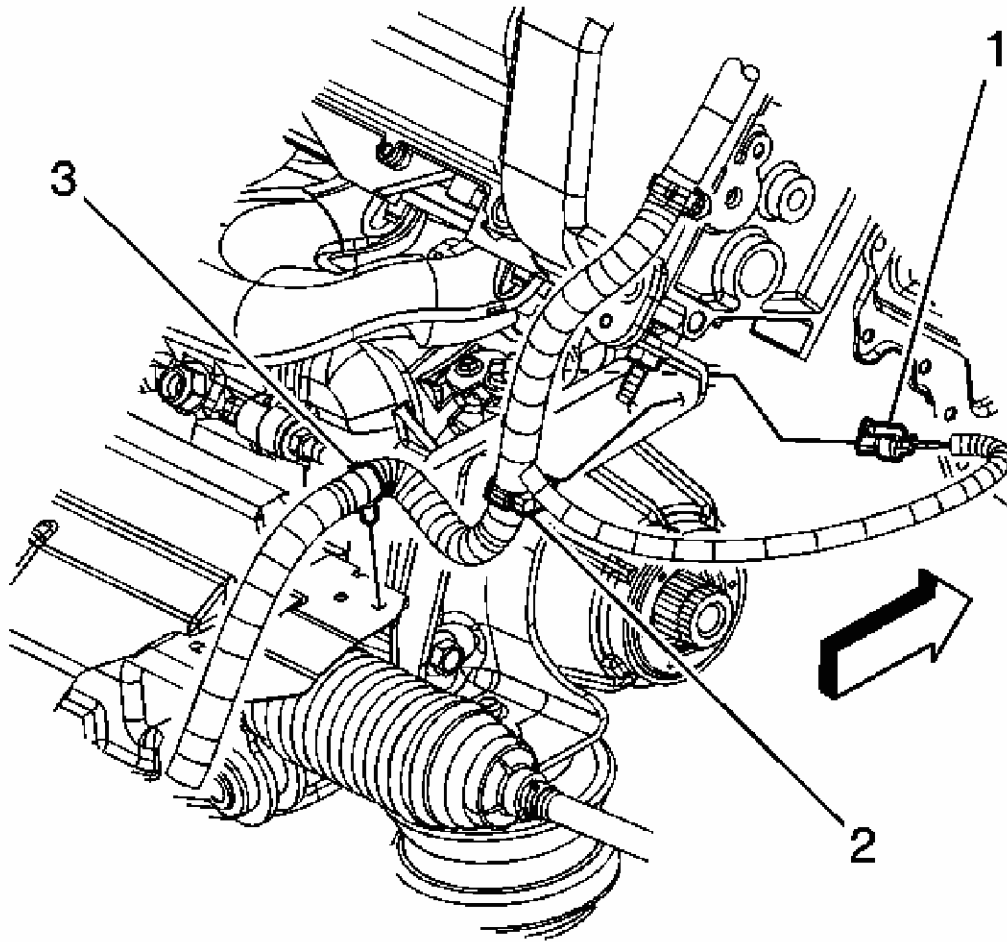


Fig. 80: Disconnecting/Connecting Engine Harness Clip At Steering Gear Heat Shield

Courtesy of GENERAL MOTORS CORP.

108. Disconnect the engine harness electrical connector (1) from the vehicle speed sensor (VSS).
109. Remove the engine harness clips (2, 3) from the rear engine mount bracket and steering gear shield.

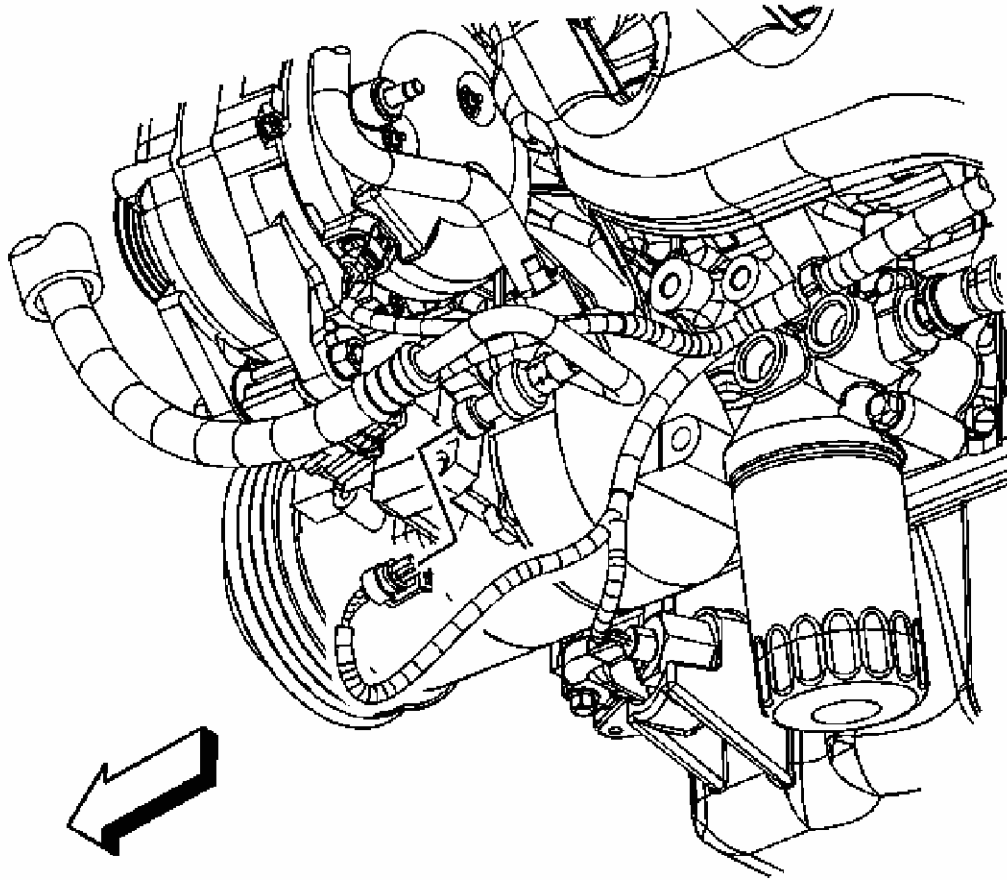


Fig. 81: Locating Engine Harness Electrical A/C Connector
Courtesy of GENERAL MOTORS CORP.

- l10. Disconnect the engine harness electrical connector from the A/C pressure sensor.

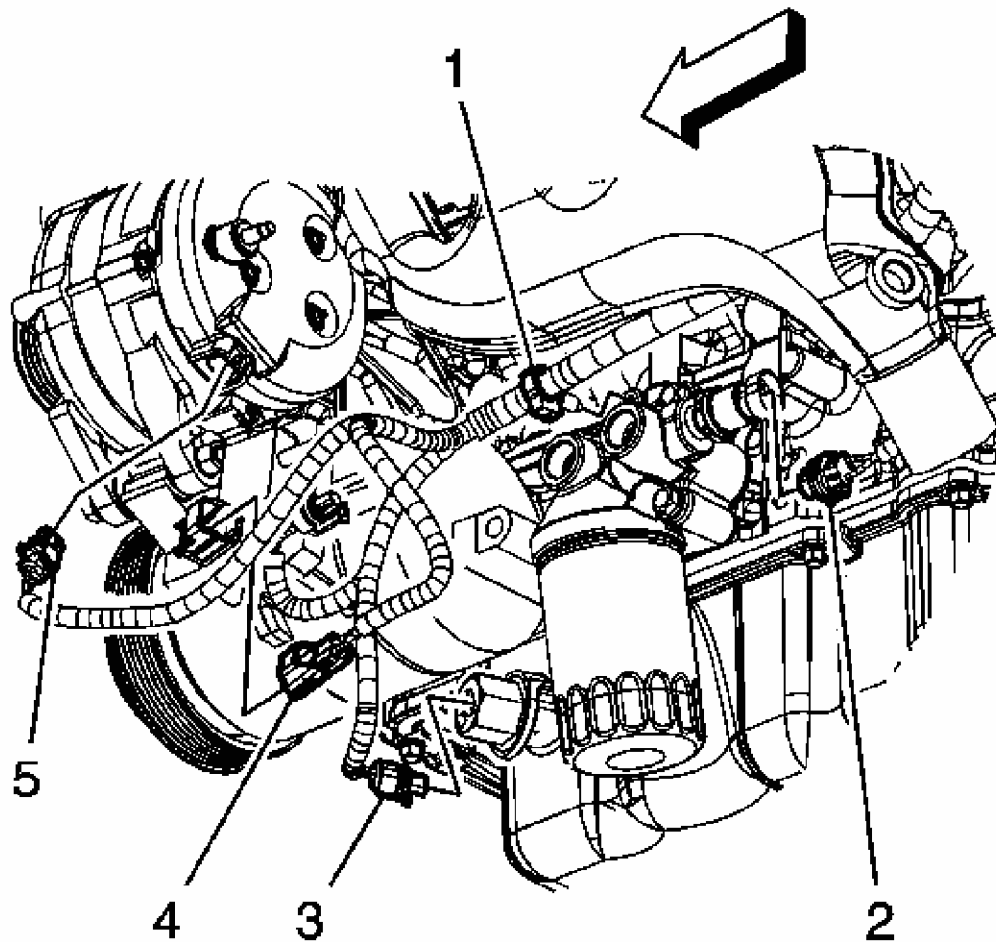


Fig. 82: Disconnecting/Connecting Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

- l11. Remove the engine harness clip (1) from the boss on the engine block.
- l12. Disconnect the following engine harness electrical connectors:
 - The oil pressure sensor (2)
 - The oil level sensor (3)
 - The A/C compressor (4)
 - The generator (5)

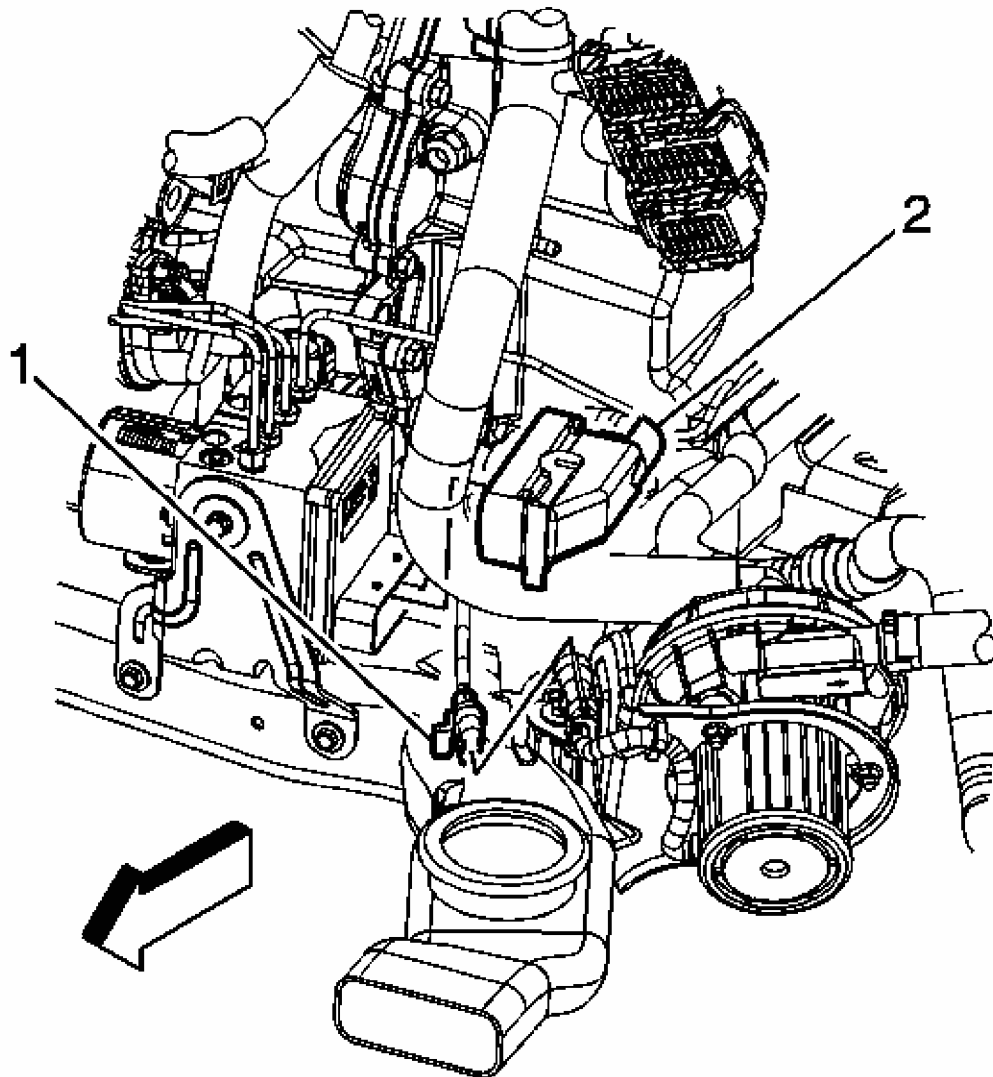


Fig. 83: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

13. Disconnect the engine harness electrical connectors from the following:
- The AIR pump (1)
 - The brake modulator (2)

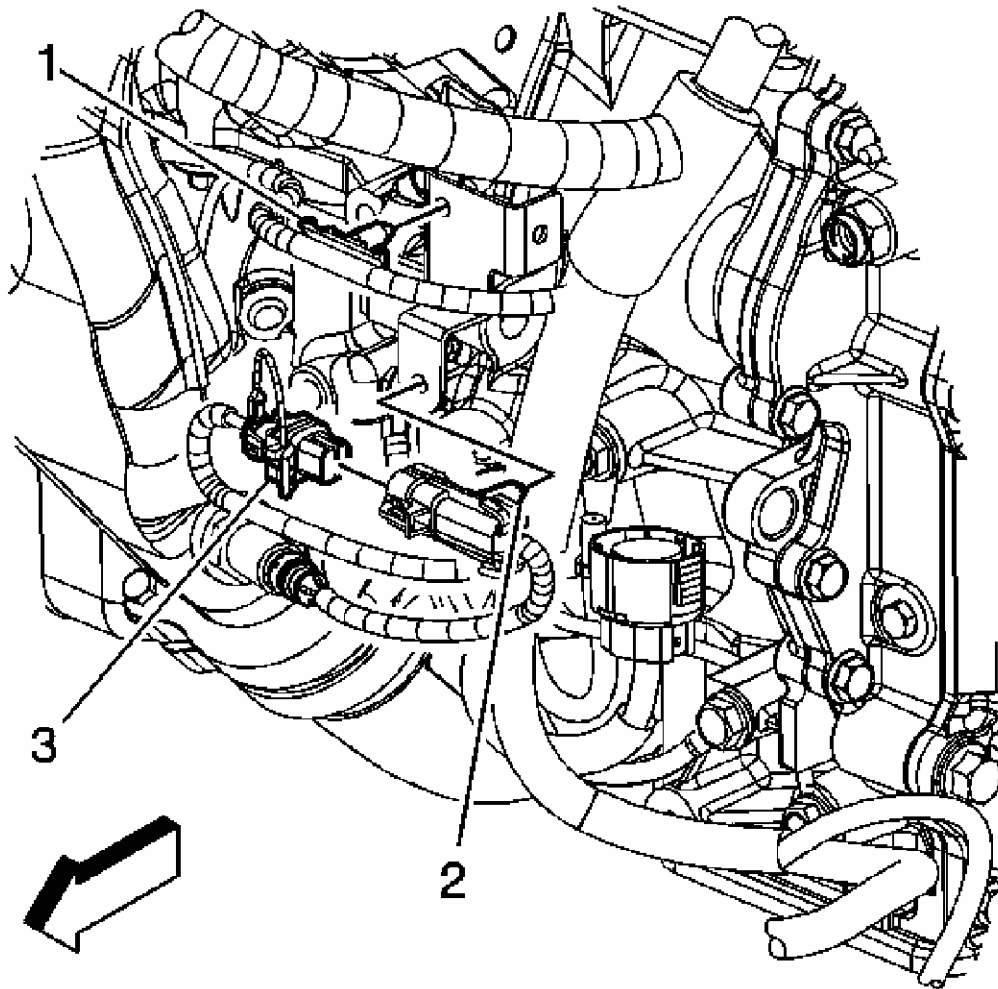


Fig. 84: View Of Engine Harness Electrical Connector & Clips
Courtesy of GENERAL MOTORS CORP.

- || 14. Remove the engine harness clip (1) from the engine bracket.
- || 15. Remove the connector position assurance (CPA) retainer.
- || 16. Disconnect the engine harness electrical connector (3) from the HO2S.

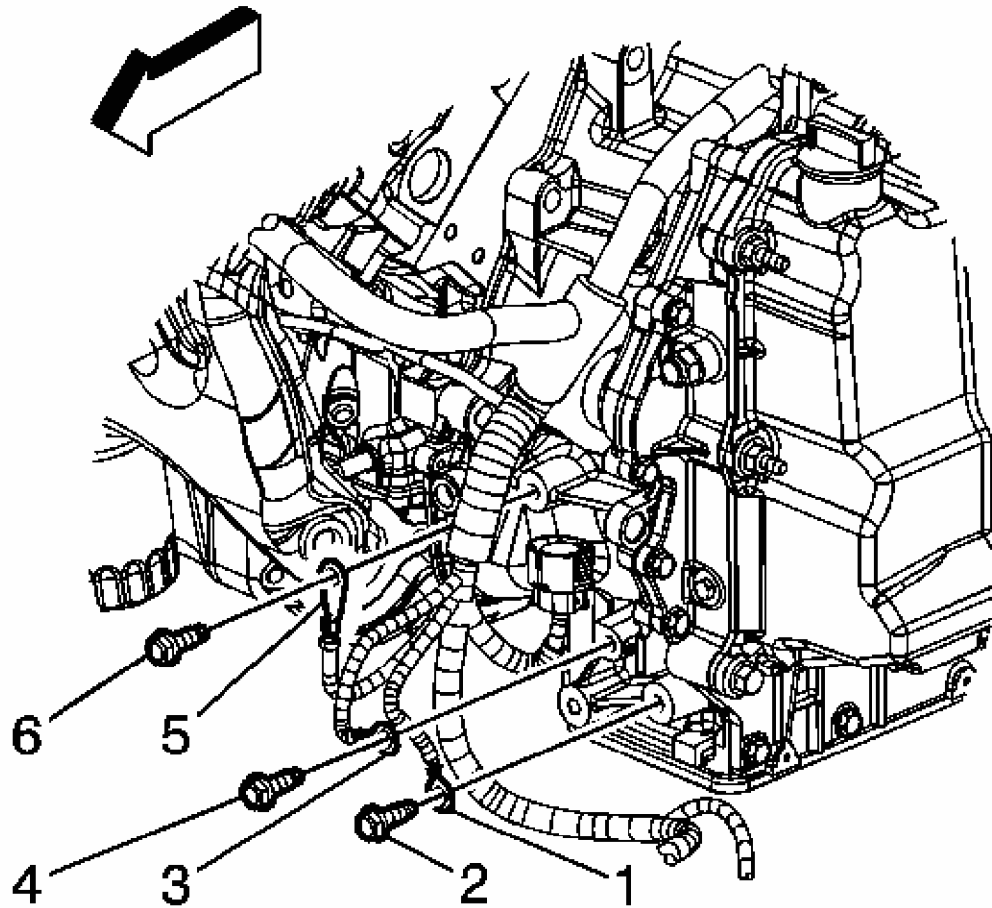


Fig. 85: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

- l17. Disconnect the engine harness electrical connector from the transaxle.
- l18. Remove the engine harness ground bolts (2, 4 and 6).
- l19. Gather all the branches of the engine harness and remove the engine harness from the engine.

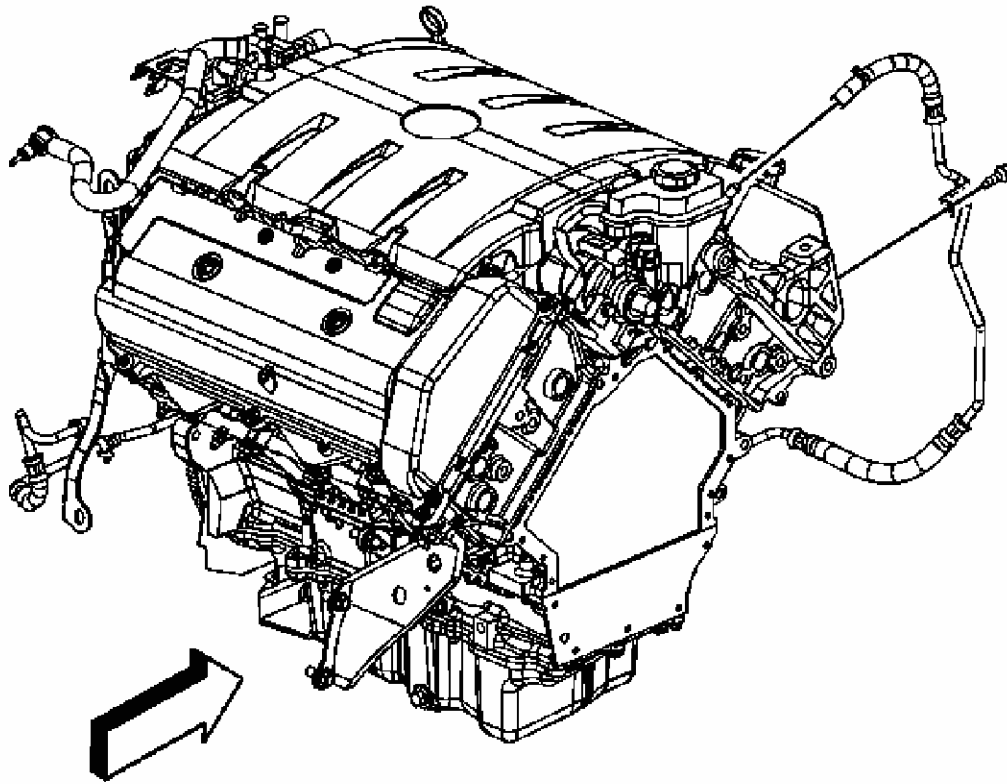


Fig. 86: Identifying Power Steering Outlet Hose
Courtesy of GENERAL MOTORS CORP.

- |20. Reposition the power steering outlet hose clamp at the pump reservoir.
- |21. Remove the power steering outlet hose from the reservoir.
- |22. Remove the power steering outlet pipe bolt from the engine mount strut bracket.

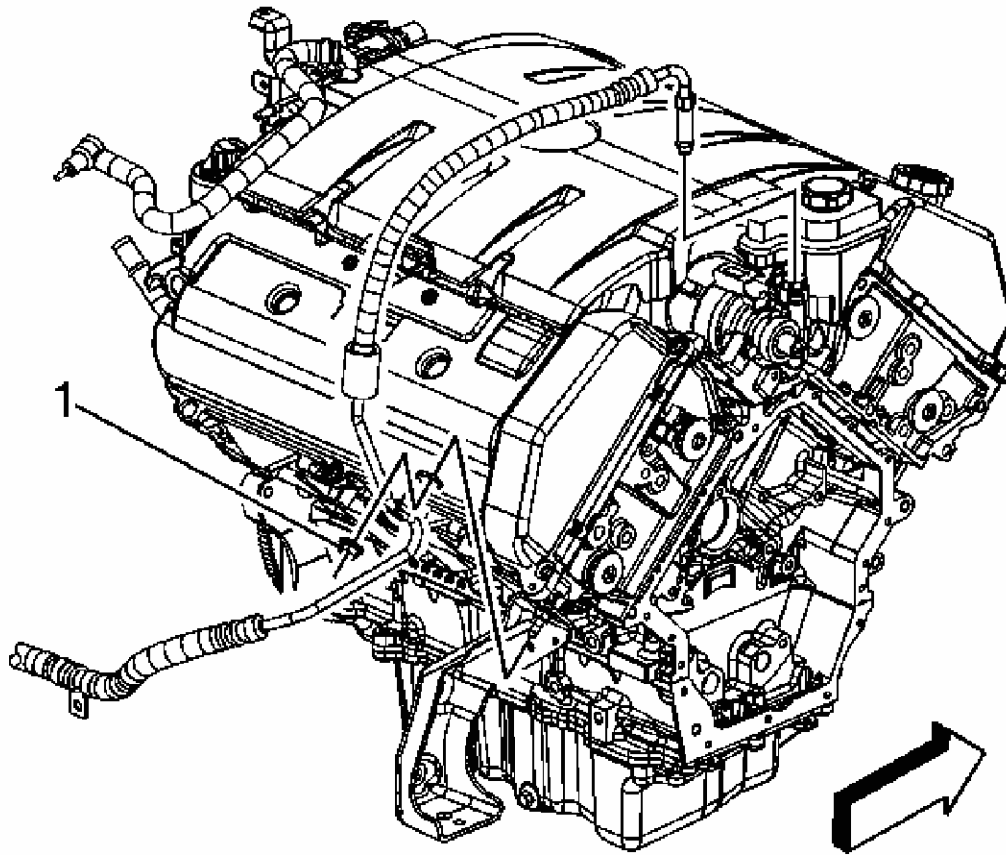


Fig. 87: Identifying Power Steering Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

- |23. Remove the power steering inlet pipe fitting from the power steering pump.
- |24. Remove the power steering inlet pipe nut (1) from the rear engine mount bracket stud.
- |25. Remove the power steering inlet pipe bracket from the stud.

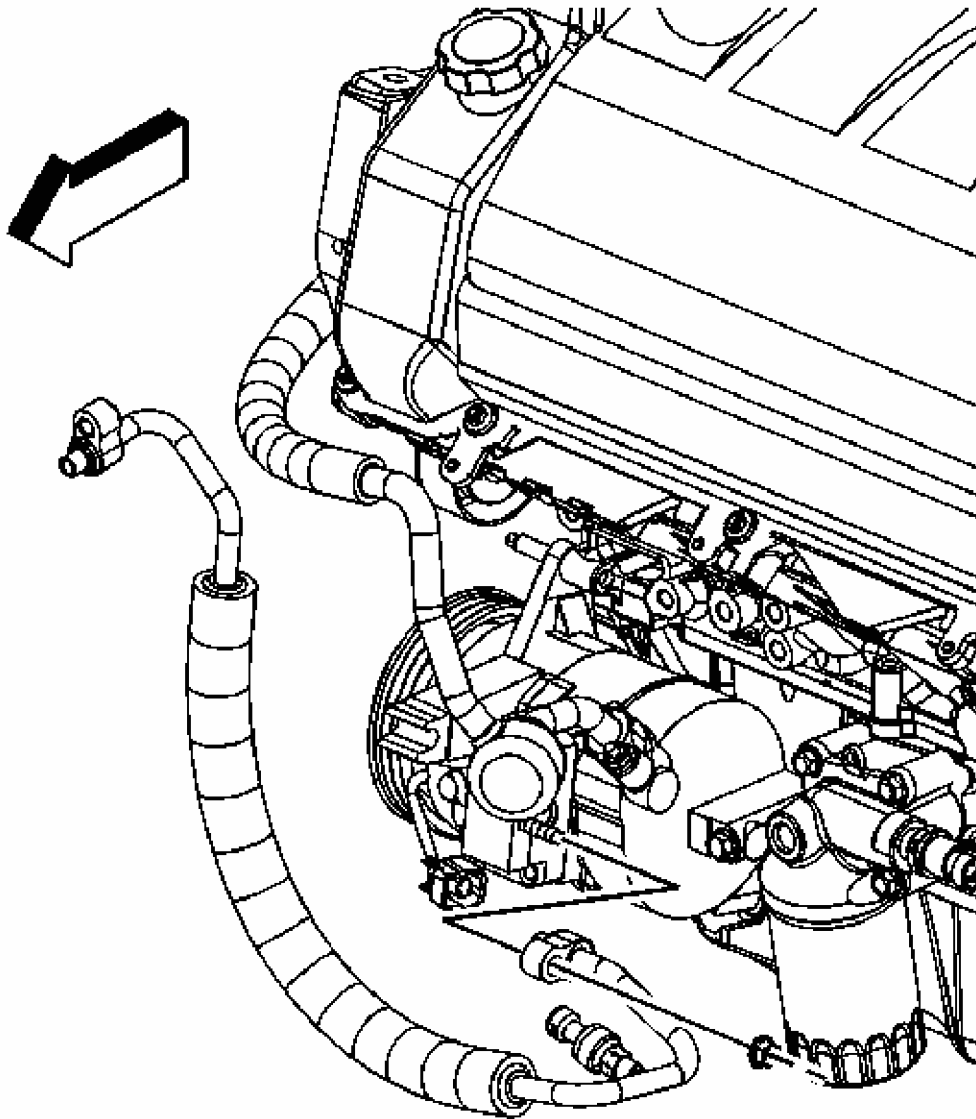


Fig. 88: View Of A/C Compressor Discharge Hose
Courtesy of GENERAL MOTORS CORP.

- |26. Remove the A/C compressor discharge hose nut at the compressor.
- |27. Unsecure the hose from the engine and remove the A/C compressor discharge hose.
- |28. Plug the A/C compressor discharge port.

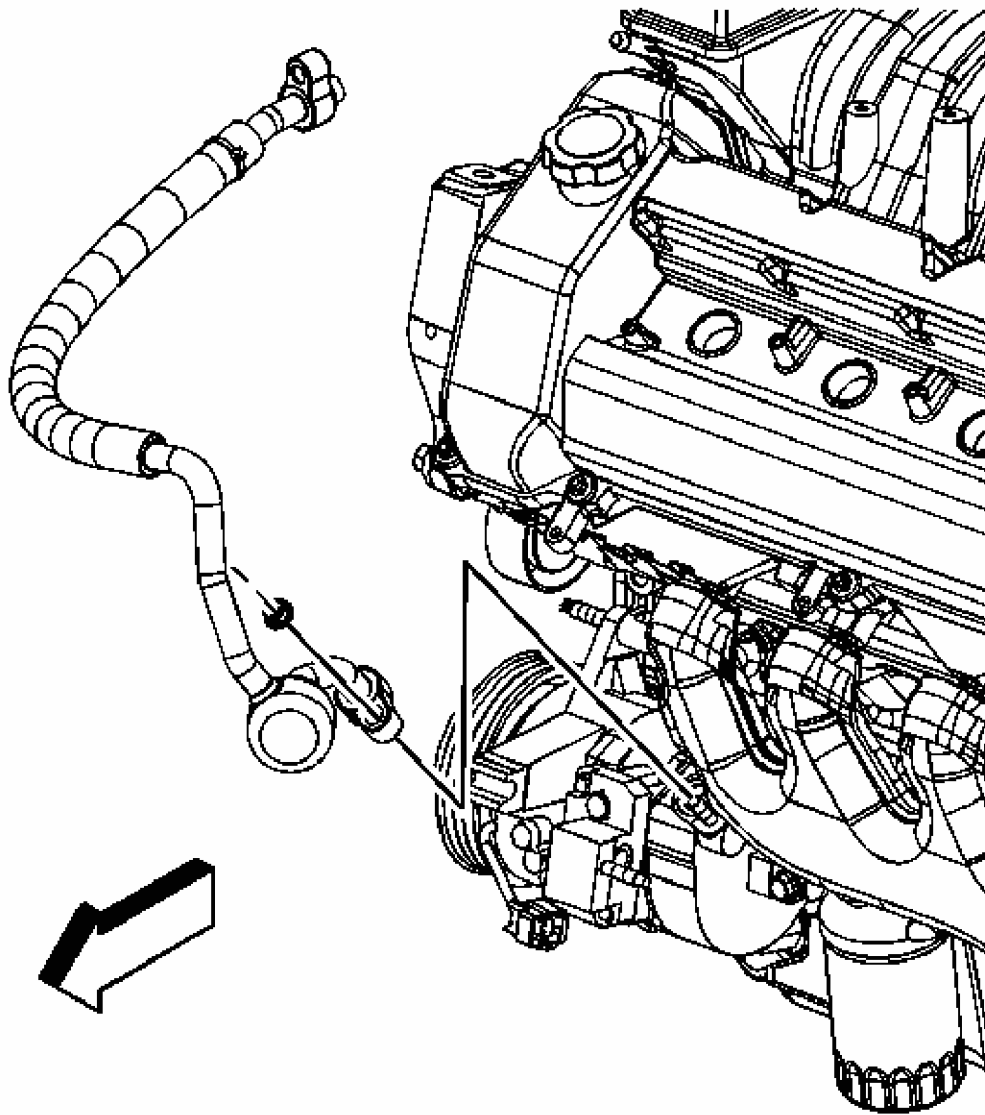


Fig. 89: View Of A/C Compressor Suction Hose
Courtesy of GENERAL MOTORS CORP.

- 129. Remove the A/C compressor suction hose nut at the compressor.
- 130. Unsecure the hose from the engine and remove the A/C compressor suction hose.
- 131. Plug the A/C compressor suction port.

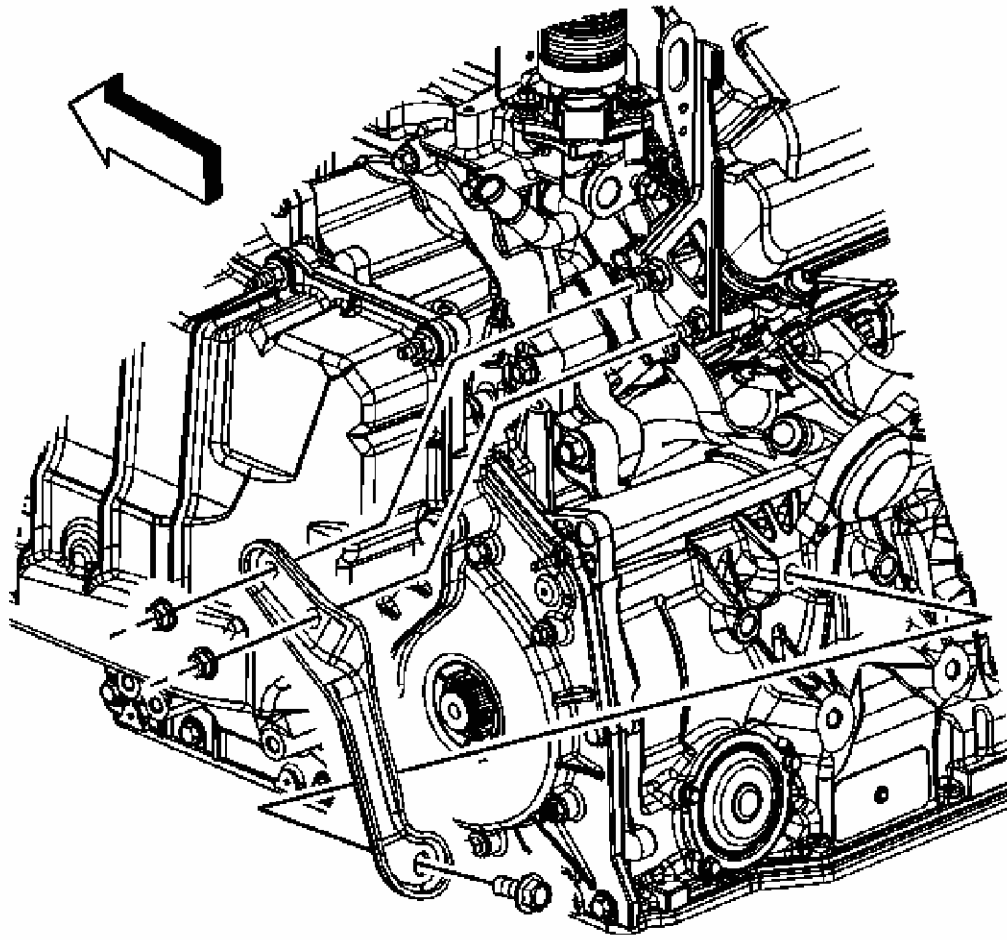


Fig. 90: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS CORP.

- 132. Remove the transaxle brace bolt.
- 133. Remove the transaxle brace nuts.
- 134. Remove the transaxle brace.

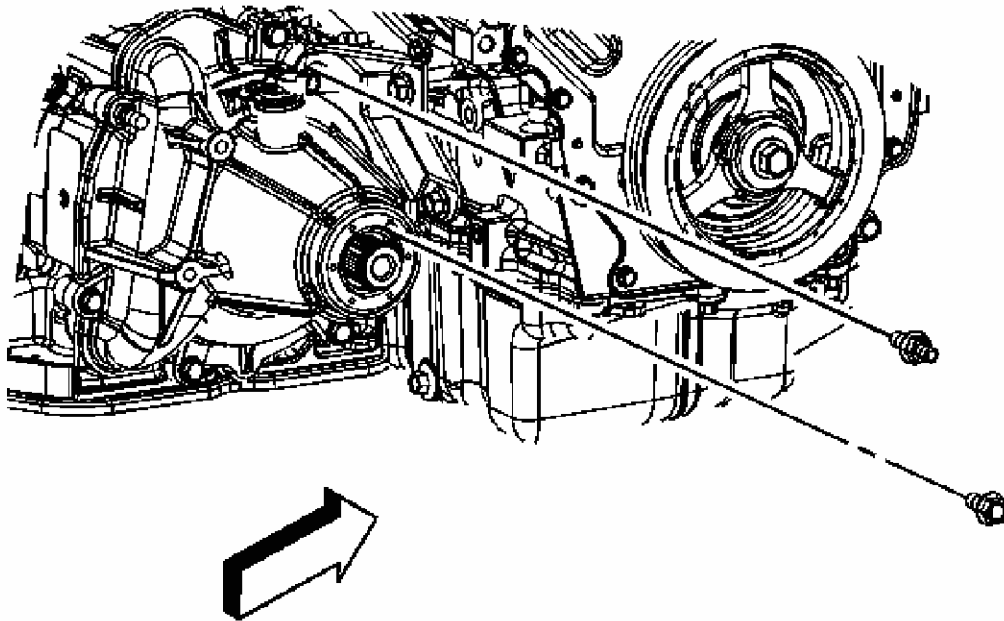


Fig. 91: Identifying Transaxle Brace Bolt/Stud
Courtesy of GENERAL MOTORS CORP.

135. Remove the transaxle brace bolt/stud to the transaxle.

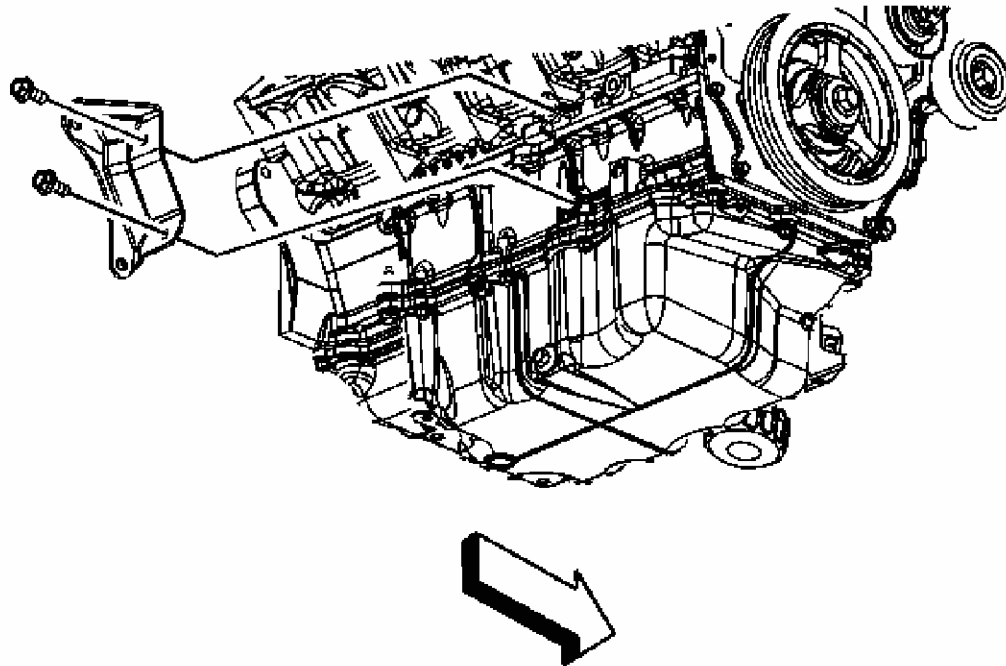


Fig. 92: Identifying Transaxle Brace Bolts & Bolts
Courtesy of GENERAL MOTORS CORP.

- 136. Remove the transaxle brace bolts to the engine.
- 137. Remove the transaxle brace.

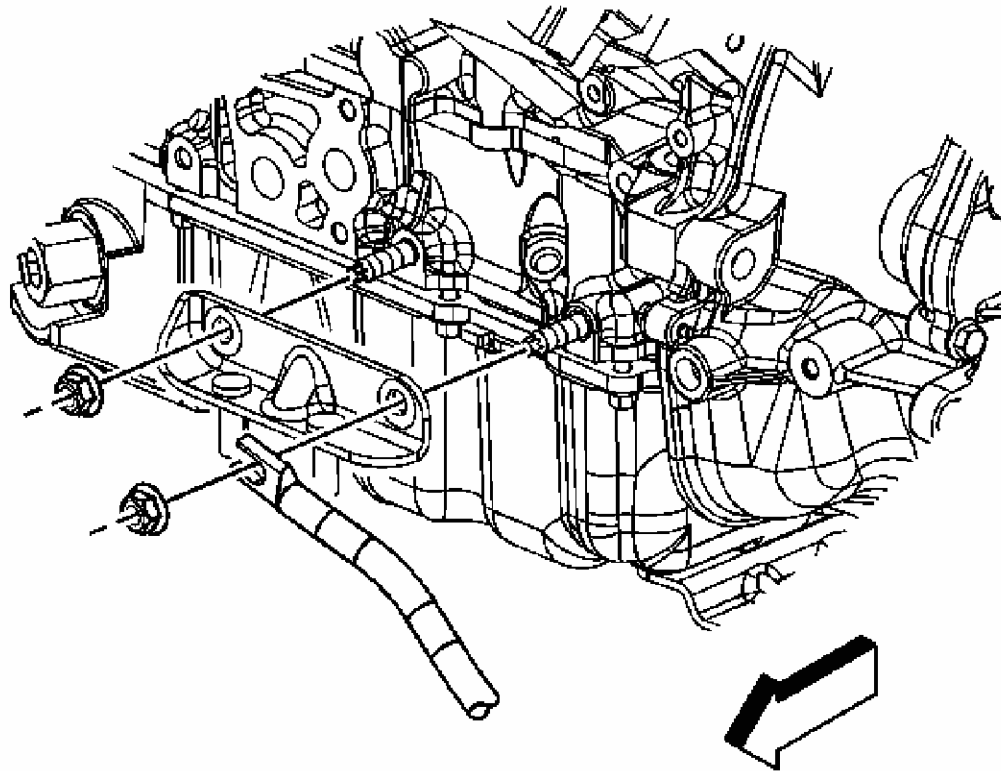


Fig. 93: View Of Lower Engine Mount Bracket-To-Engine Stud Nuts
Courtesy of GENERAL MOTORS CORP.

138. Loosen the front engine mount bracket nut with the transaxle brace behind it.

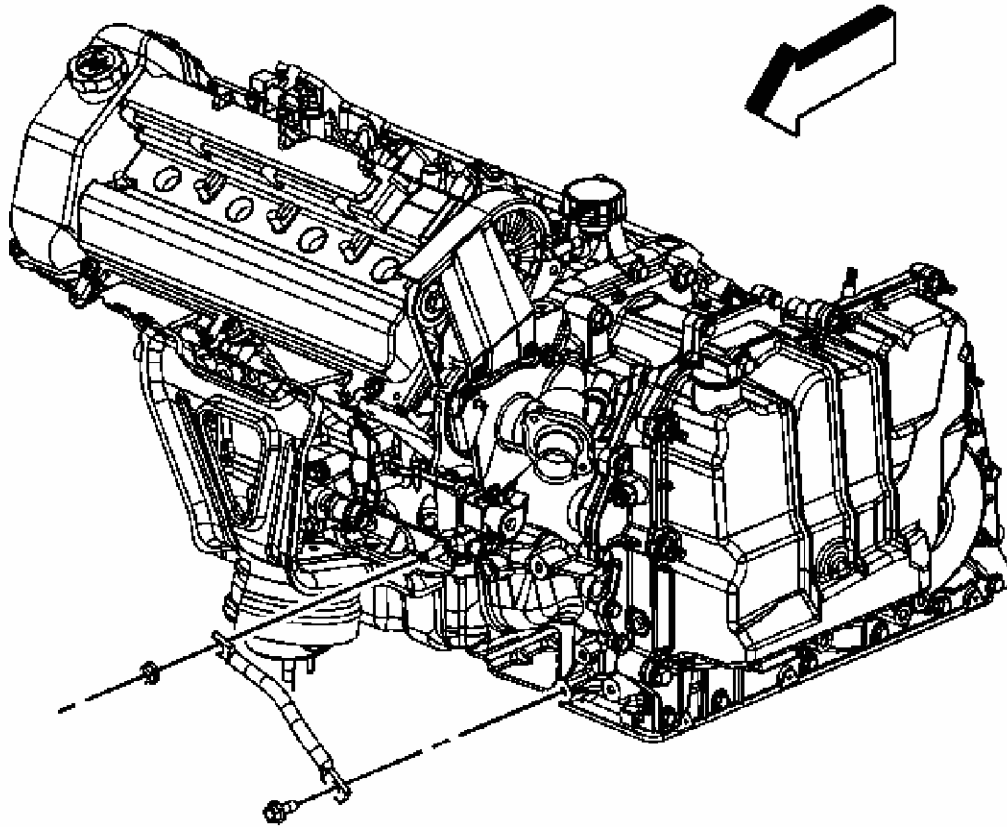


Fig. 94: View Of Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS CORP.

- |39. Remove the transaxle brace bolt.
- |40. Remove the transaxle brace.

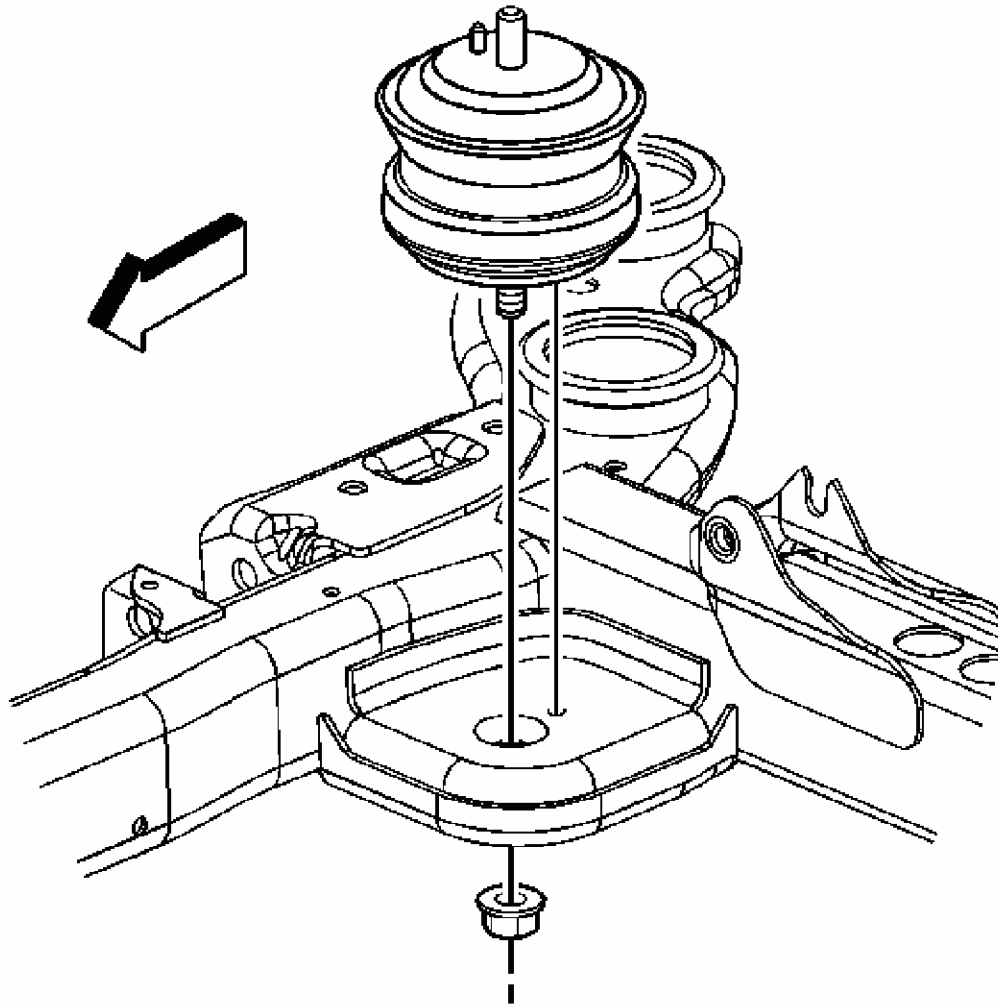


Fig. 95: View Of Right Engine Mount To Frame Nut
Courtesy of GENERAL MOTORS CORP.

- l41. Install an engine lift chain to the engine lift brackets and attach an engine lifting device.
- l42. Remove the rear engine mount to frame nut.

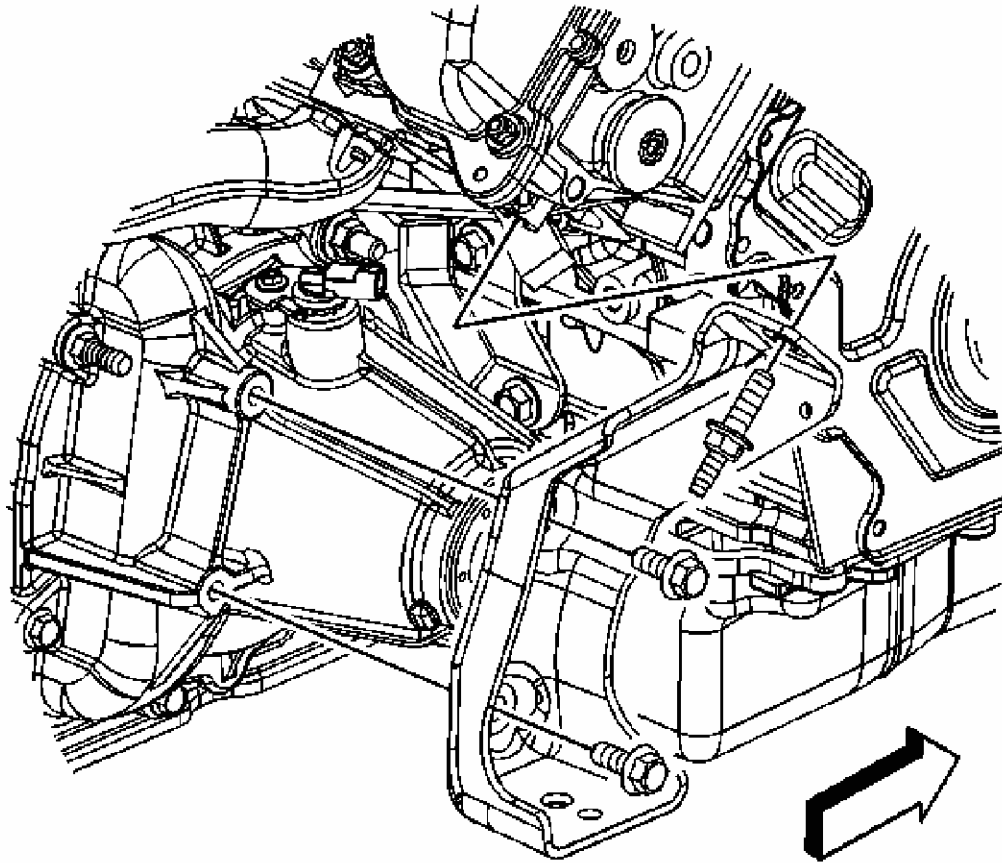


Fig. 96: Identifying Right Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

- |43. Remove the rear engine mount bracket bolts and stud.
- |44. Remove the rear engine mount bracket.

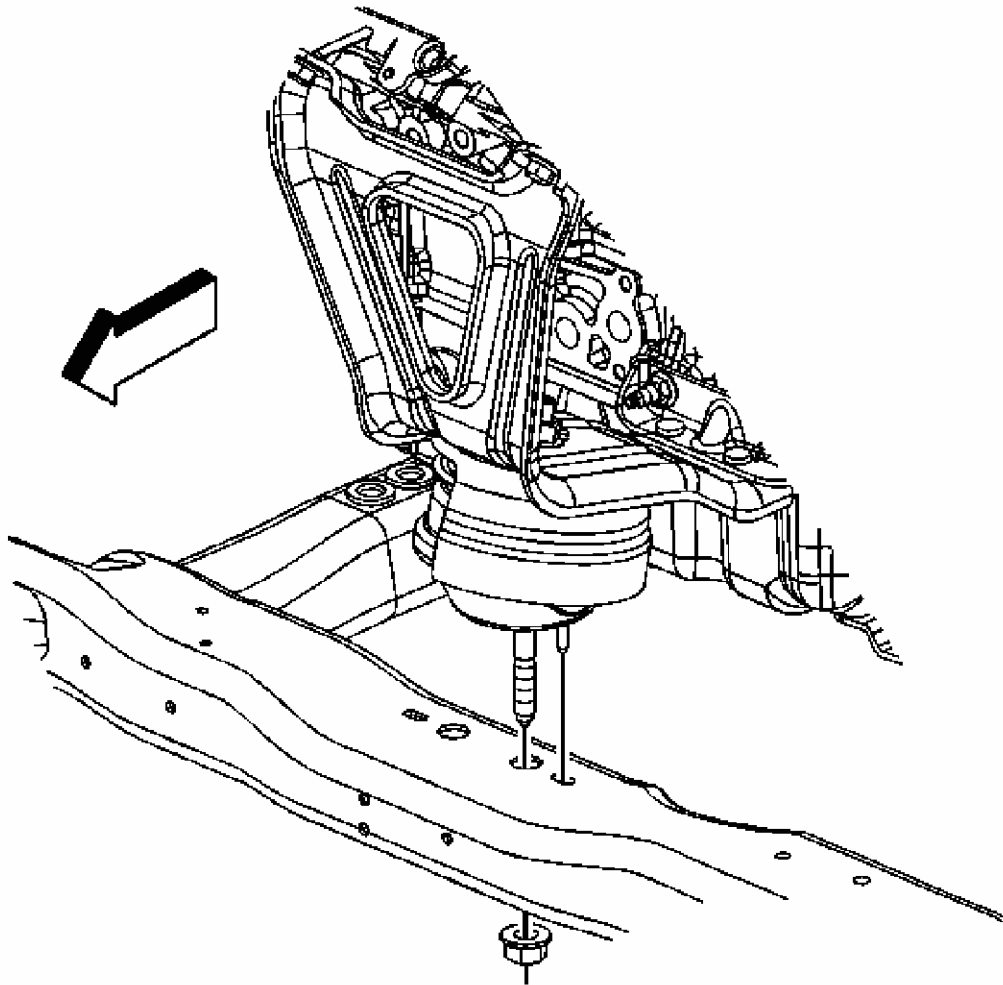


Fig. 97: Identifying Engine Mount-To-Frame Nut
Courtesy of GENERAL MOTORS CORP.

145. Remove the front engine mount to frame nut.

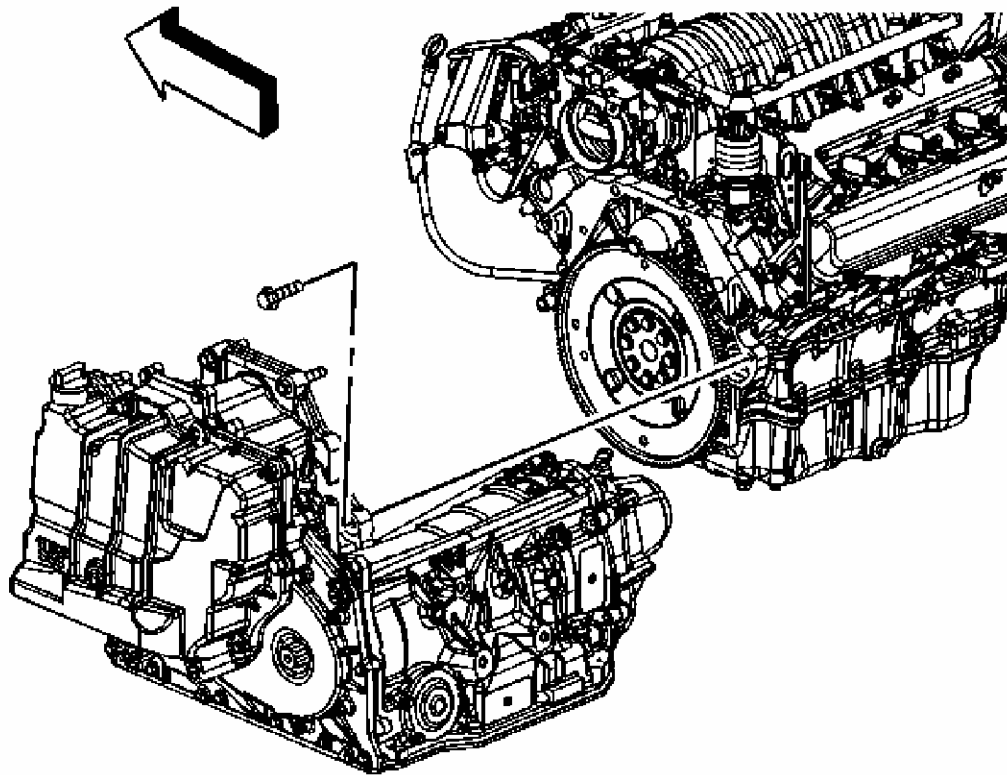


Fig. 98: Identifying Rear Transaxle Bolt
Courtesy of GENERAL MOTORS CORP.

146. Remove the rear transaxle bolt.

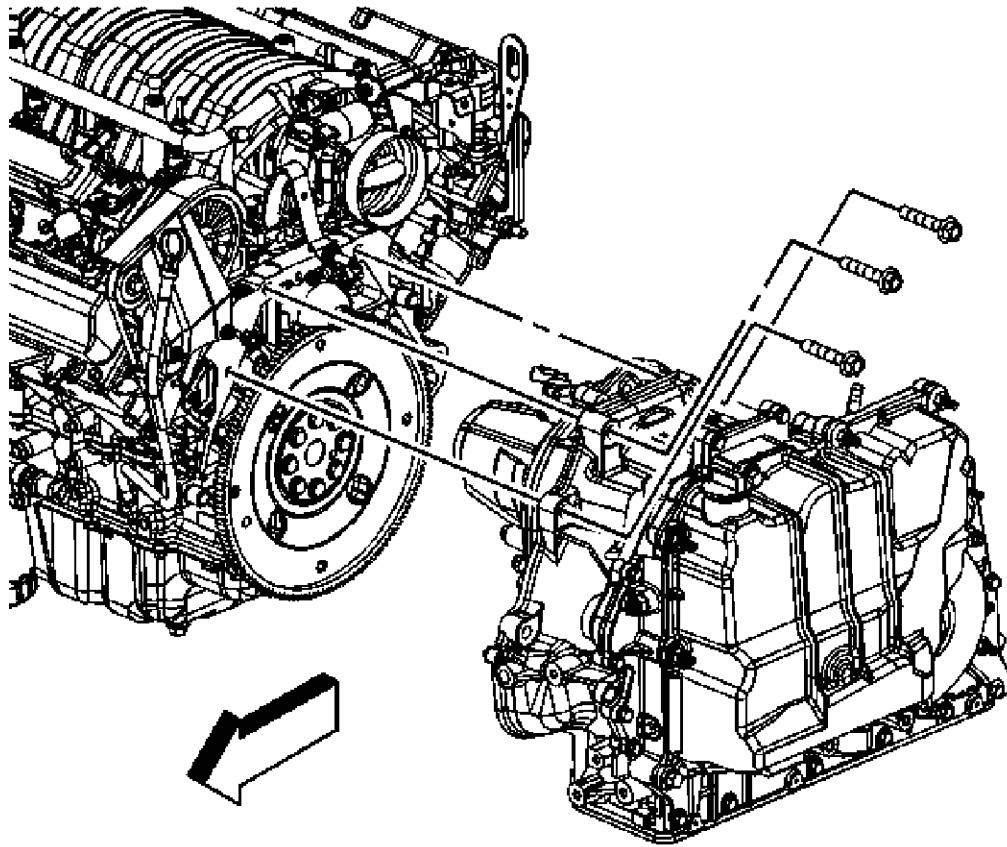


Fig. 99: Identifying Upper Transaxle Bolts
Courtesy of GENERAL MOTORS CORP.

- |47. Remove the upper transaxle bolts.
- |48. Separate the engine from the transaxle.
- |49. Raise the engine from the supported frame and transaxle assembly.

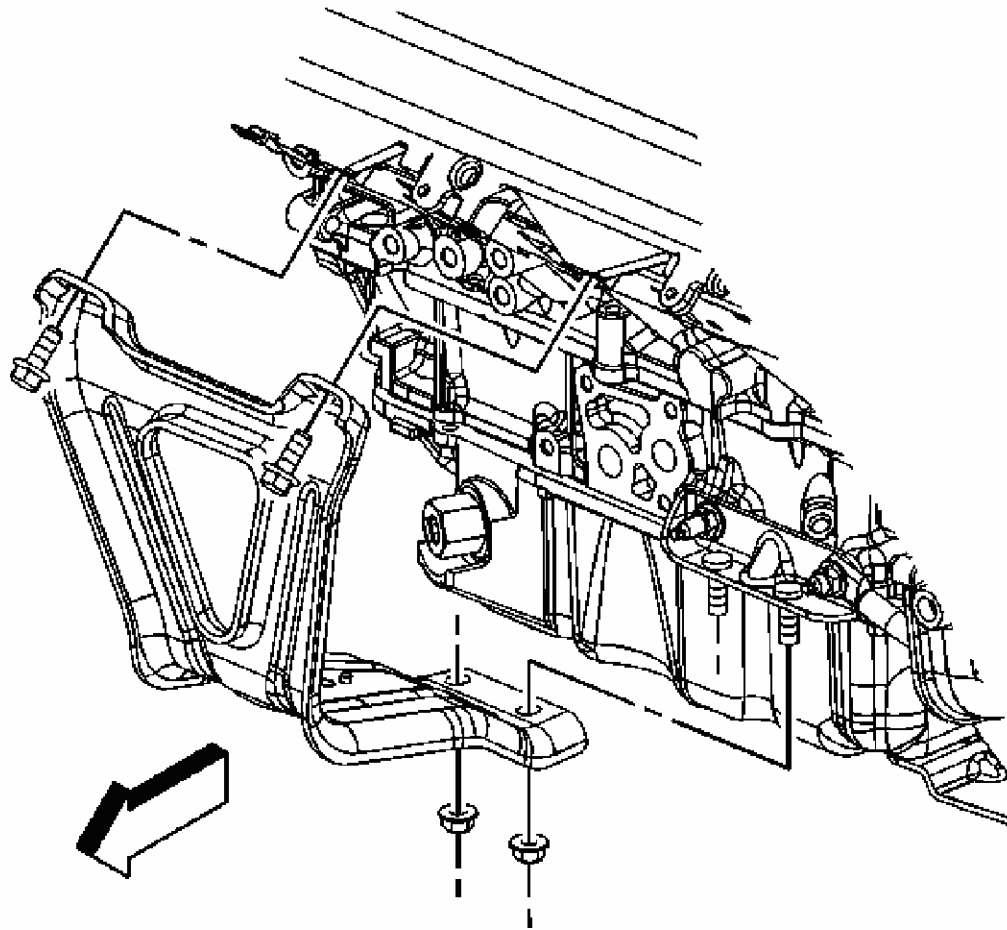


Fig. 100: Identifying Front Engine Mount Bracket Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

- | 50. Remove the front engine mount bracket bolts/nuts.
- | 51. Remove the front engine mount bracket.
- | 52. Install the engine assembly to a suitable engine stand.

INSTALLATION PROCEDURE

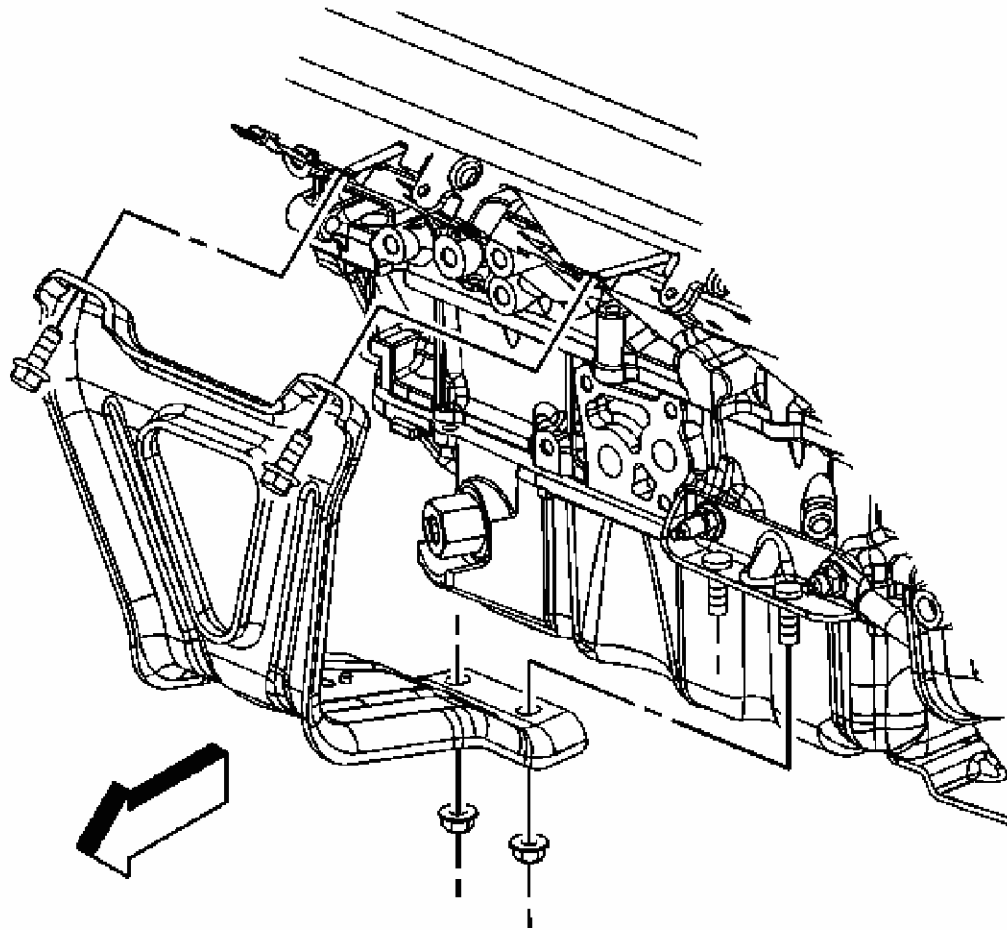


Fig. 101: Identifying Front Engine Mount Bracket Bolts/Nuts
Courtesy of GENERAL MOTORS CORP.

1. Install the front engine mount bracket.

NOTE: Refer to Fastener Notice .

2. Install the front engine mount bracket bolts/nuts.

Tighten: Tighten the bolts/nuts 50 N.m (37 lb ft).

3. Install an engine lift chain to the engine lift brackets and attach an engine lifting device.
4. Remove the engine assembly from the engine stand.

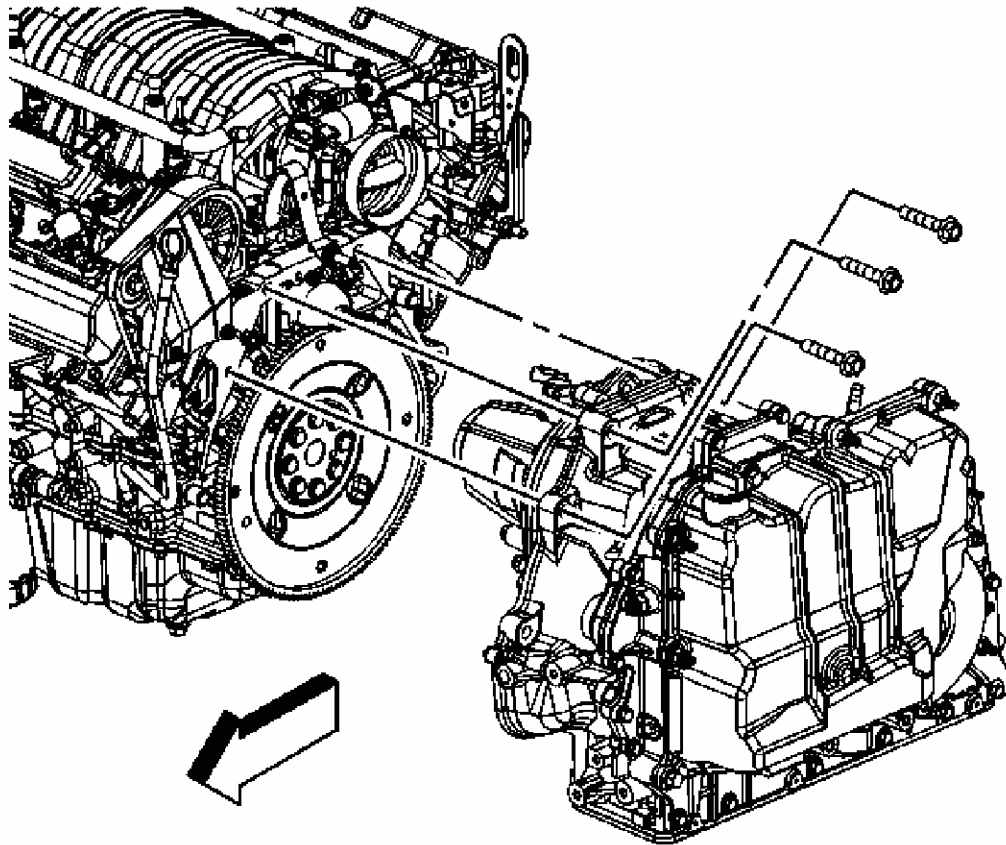


Fig. 102: Identifying Upper Transaxle Bolts
Courtesy of GENERAL MOTORS CORP.

5. Carefully position and install the engine to the supported frame and transaxle, aligning the engine dowel pins to the transaxle.
6. Install the upper transaxle bolts.

Tighten: Tighten the bolts to 75 N.m (55 lb ft).

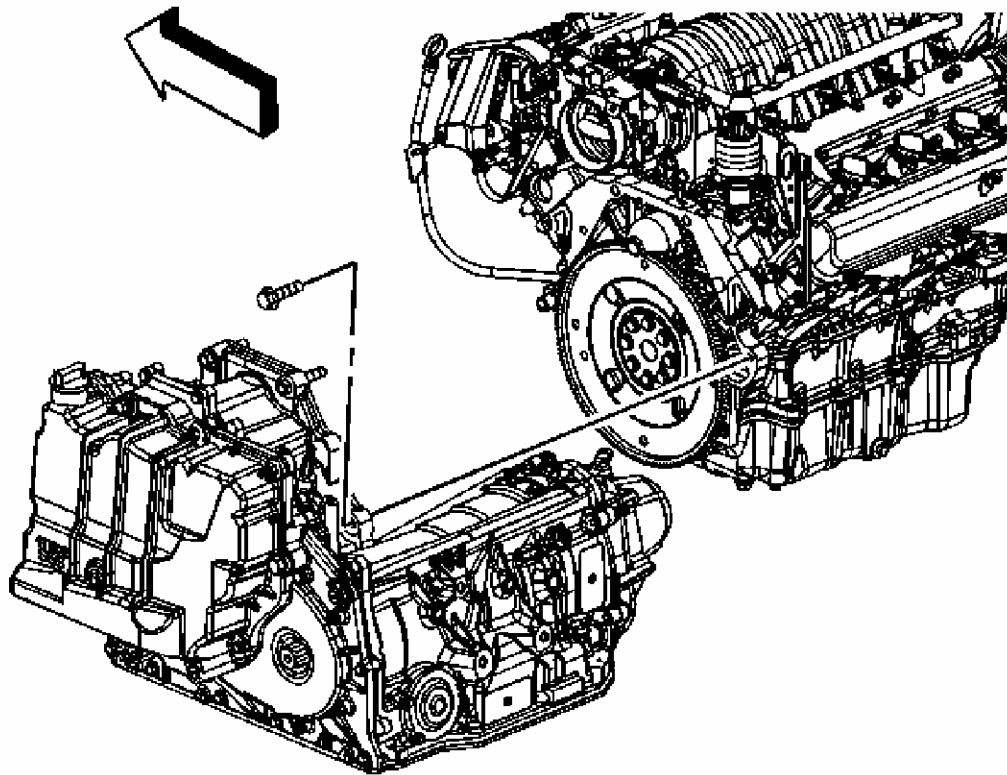


Fig. 103: Identifying Rear Transaxle Bolt
Courtesy of GENERAL MOTORS CORP.

7. Install the rear transaxle bolt.

Tighten: Tighten the bolt to 75 N.m (55 lb ft).

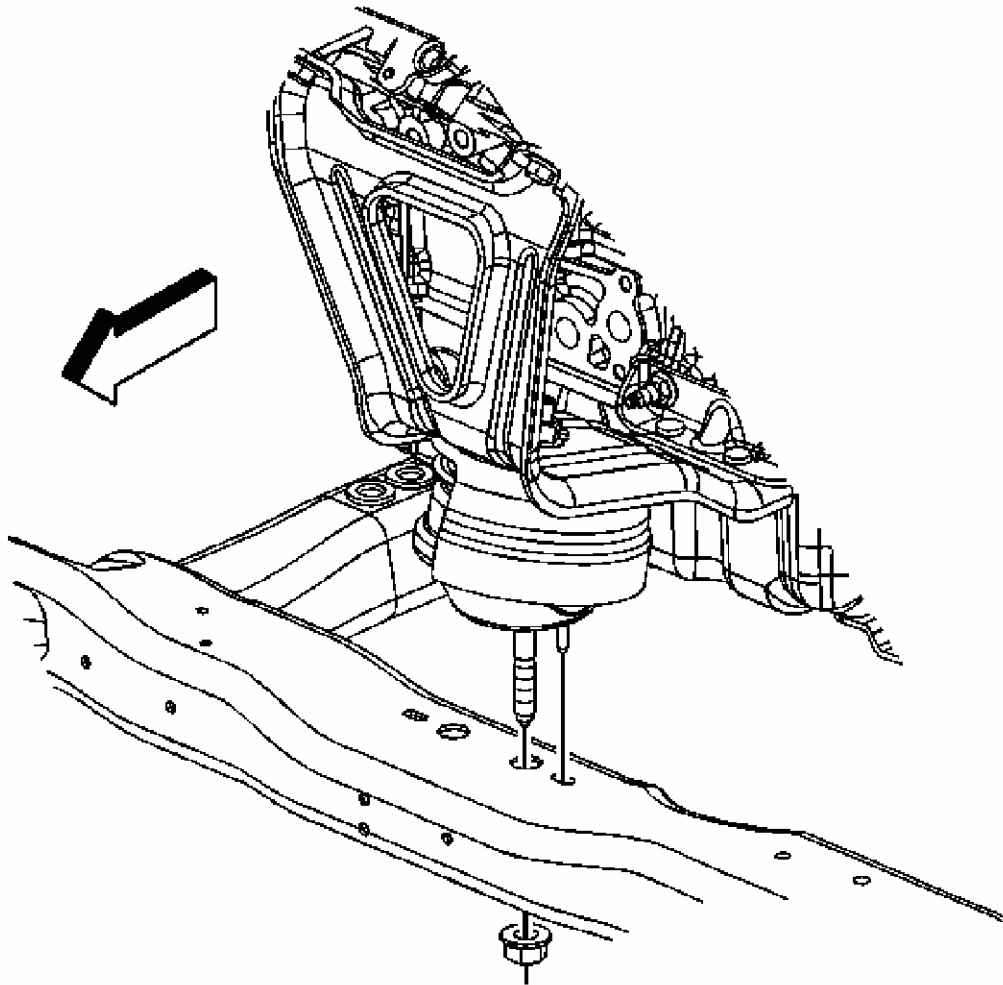


Fig. 104: Identifying Engine Mount-To-Frame Nut
Courtesy of GENERAL MOTORS CORP.

8. Install the front engine mount to frame nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

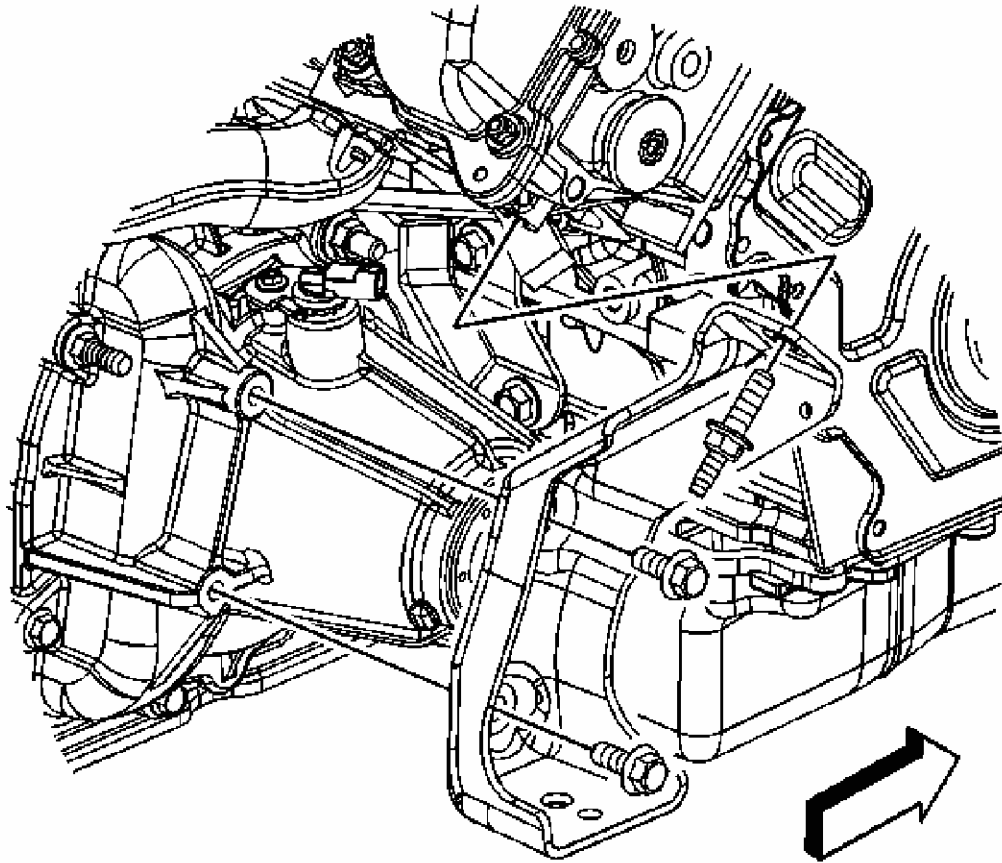


Fig. 105: Identifying Right Engine Mount Bracket
Courtesy of GENERAL MOTORS CORP.

9. Position the rear engine mount bracket to the engine and transaxle.
10. Install the rear engine mount bracket bolts and stud.

Tighten: Tighten the bolts/stud to 73 N.m (54 lb ft).

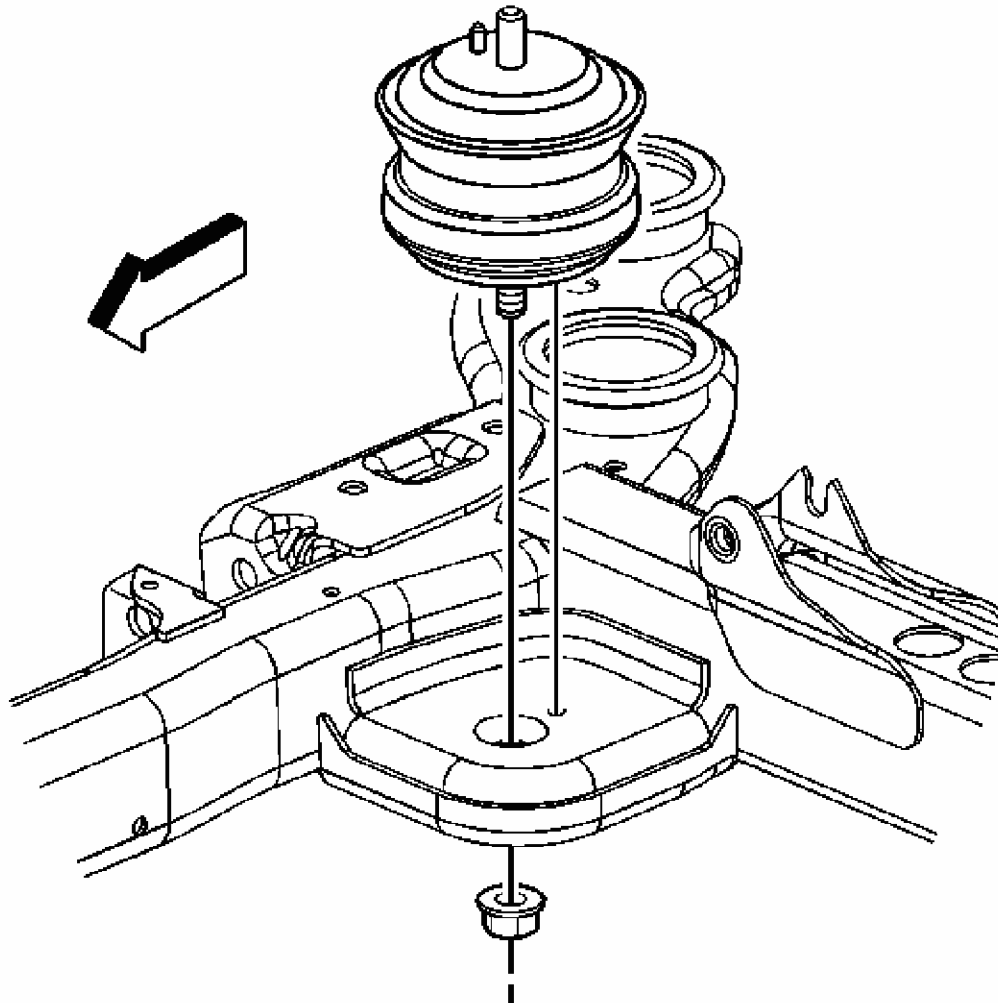


Fig. 106: View Of Right Engine Mount To Frame Nut
Courtesy of GENERAL MOTORS CORP.

11. Install the rear engine mount to frame nut.

Tighten: Tighten the nut to 80 N.m (59 lb ft).

12. Remove the engine lifting device and lift chain.

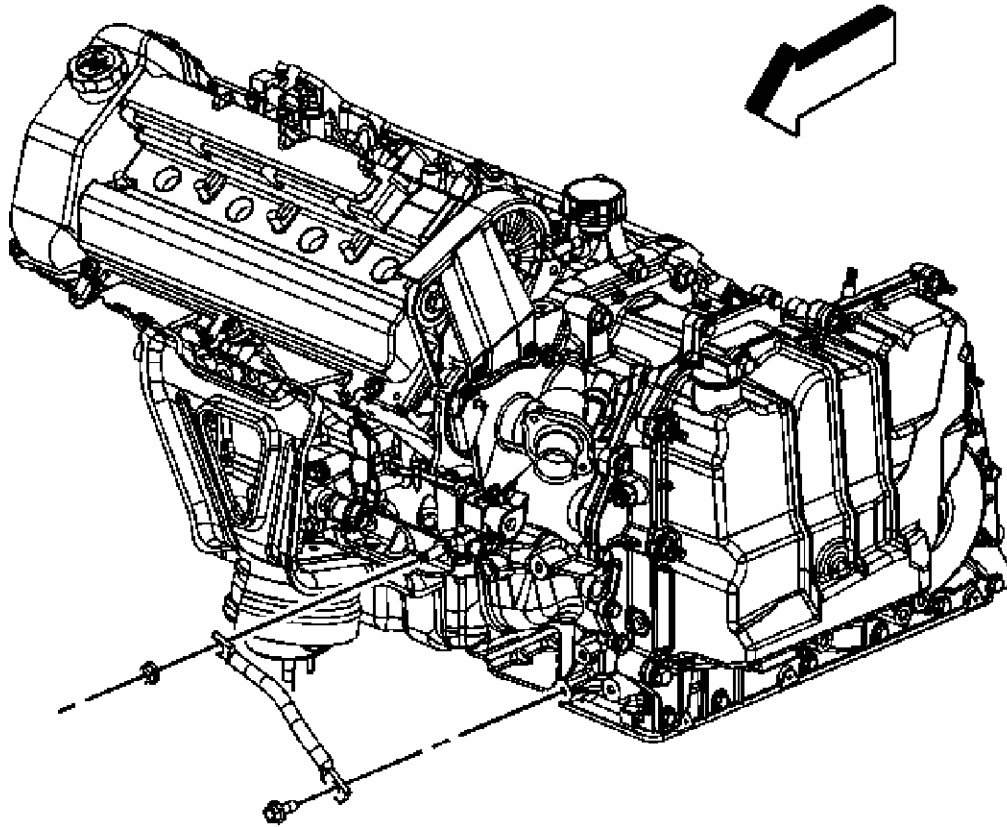


Fig. 107: View Of Transaxle Brace & Bolt
Courtesy of GENERAL MOTORS CORP.

13. Install the transaxle brace.
14. Install the transaxle brace bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

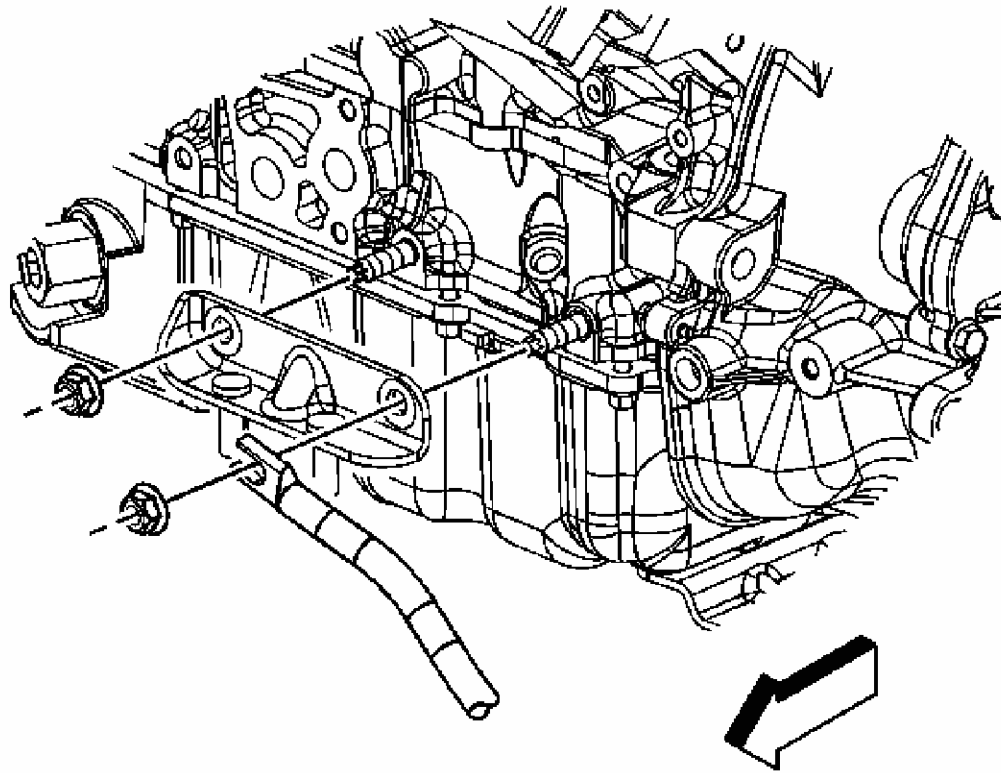


Fig. 108: View Of Lower Engine Mount Bracket-To-Engine Stud Nuts
Courtesy of GENERAL MOTORS CORP.

15. Tighten the front engine mount bracket nut with the transaxle brace behind it.

Tighten: Tighten the nut to 50 N.m (37 lb ft).

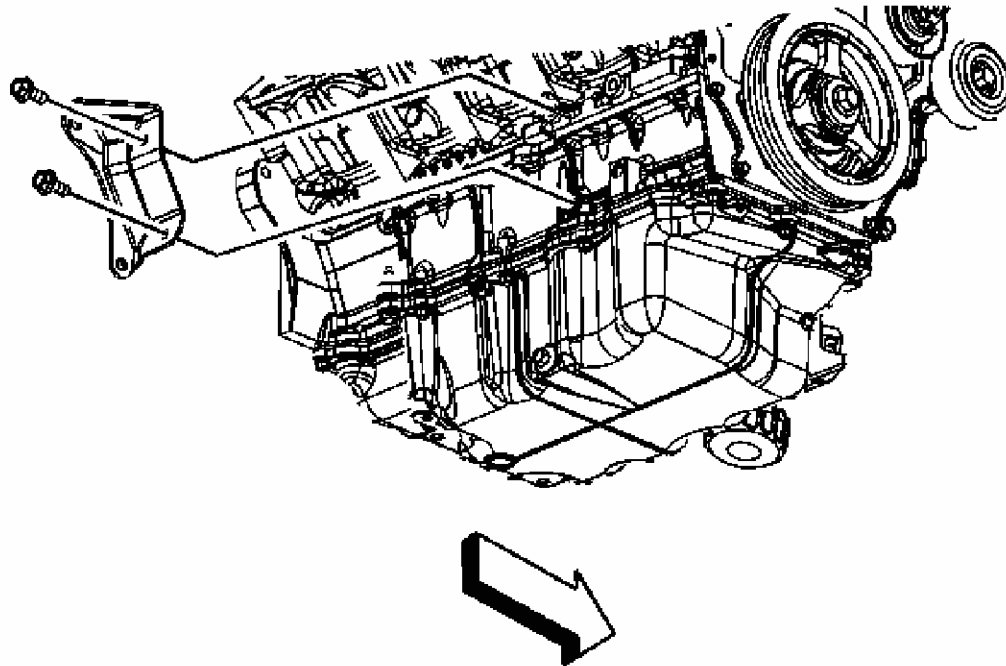


Fig. 109: Identifying Transaxle Brace Bolts & Bolts
Courtesy of GENERAL MOTORS CORP.

16. Position the transaxle brace to the engine and transaxle.
17. Install the transaxle brace bolts to the engine.

Tighten: Tighten the bolts to 50 N.m (37 lb ft).

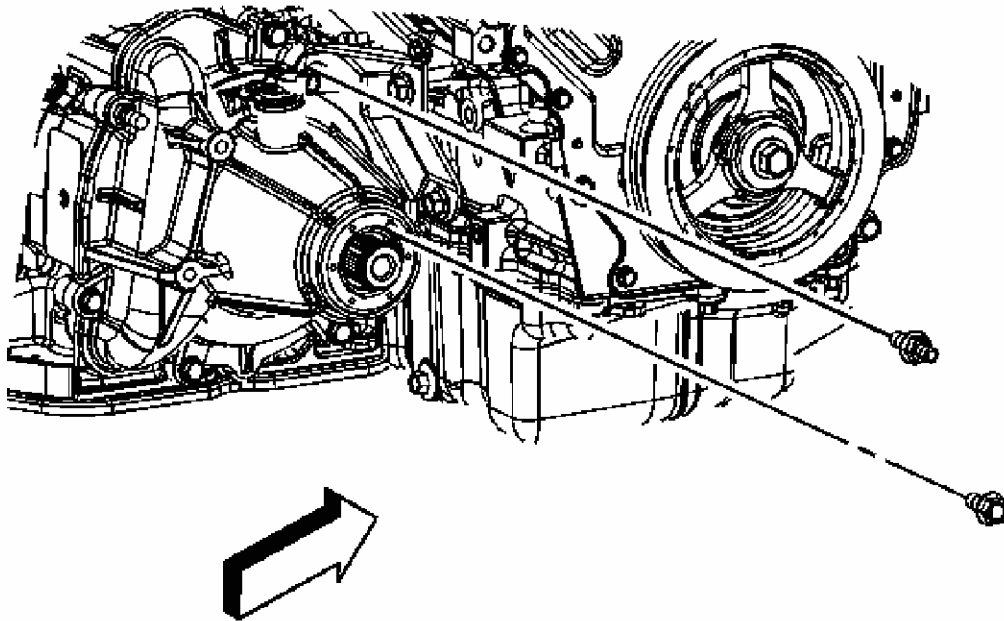


Fig. 110: Identifying Transaxle Brace Bolt/Stud
Courtesy of GENERAL MOTORS CORP.

18. Install the transaxle brace bolt/stud to the transaxle.

Tighten: Tighten the bolt/stud to 50 N.m (37 lb ft).

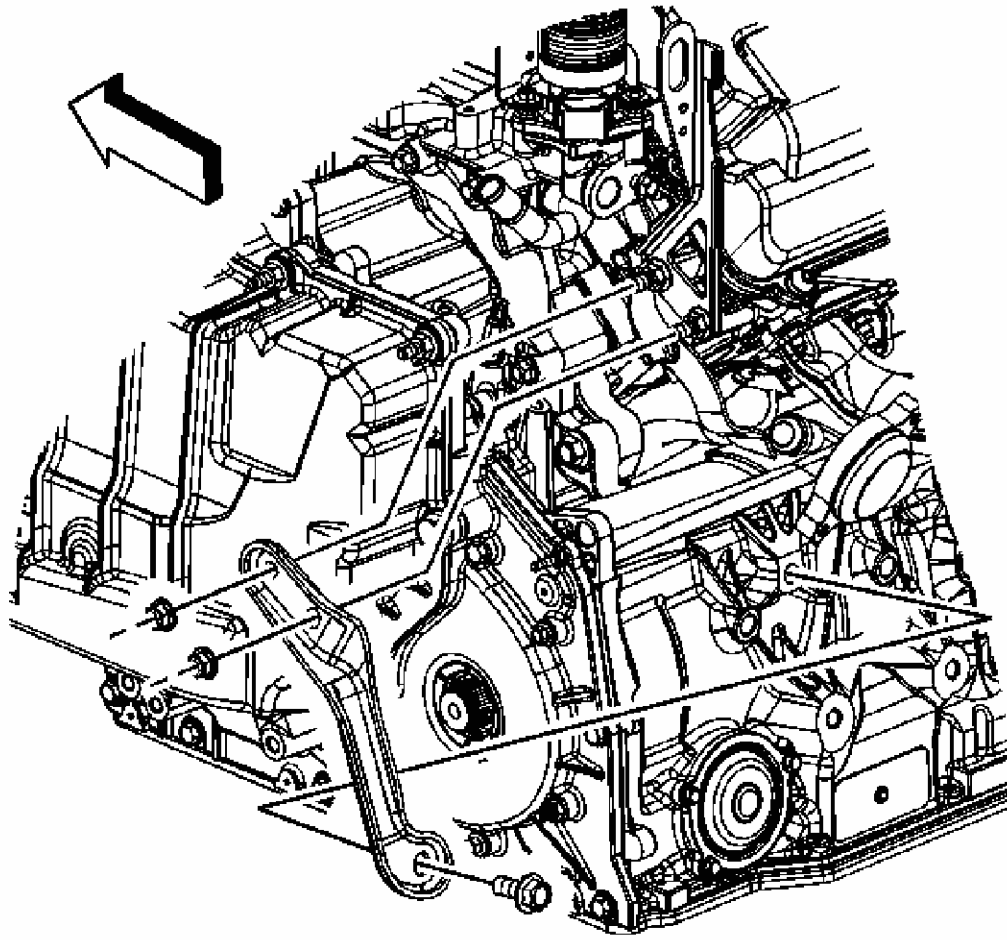


Fig. 111: Identifying Engine Lift Bracket
Courtesy of GENERAL MOTORS CORP.

19. Install the transaxle brace to the lift bracket studs.
20. Install the transaxle brace bolt.

Tighten: Tighten the bolt to 50 N.m (37 lb ft).

21. Install the transaxle brace nuts.

Tighten: Tighten the nut to 50 N.m (37 lb ft).

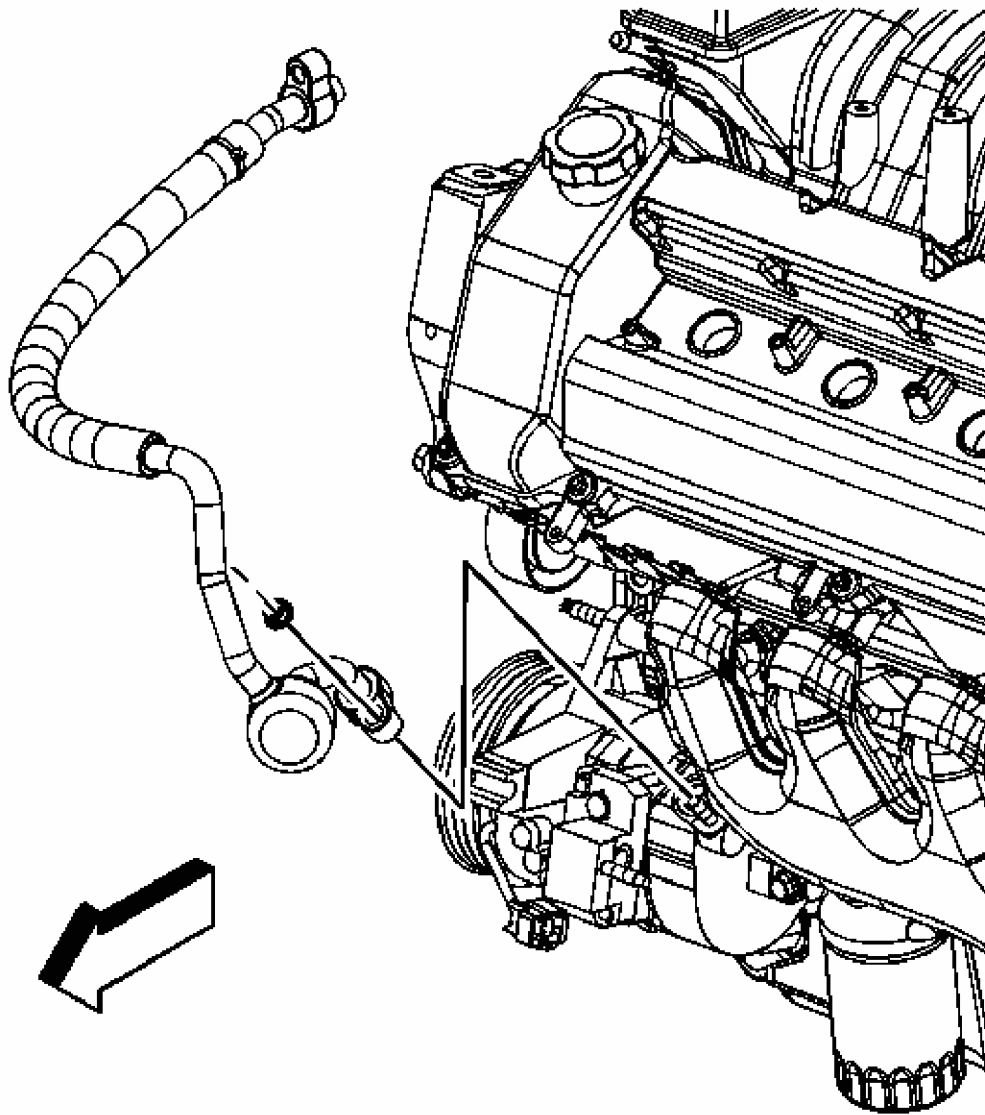


Fig. 112: View Of A/C Compressor Suction Hose
Courtesy of GENERAL MOTORS CORP.

22. Remove the plug from the A/C compressor suction port.
23. Remove and discard the old sealing washer from the compressor end of the suction hose.
24. Install a NEW sealing washer to the compressor end of the suction hose.
25. Install the A/C compressor suction hose the compressor.
26. Install the A/C compressor suction hose nut at the compressor.

Tighten: Tighten the nut to 16 N.m (12 lb ft).

27. Secure the suction hose to the engine.

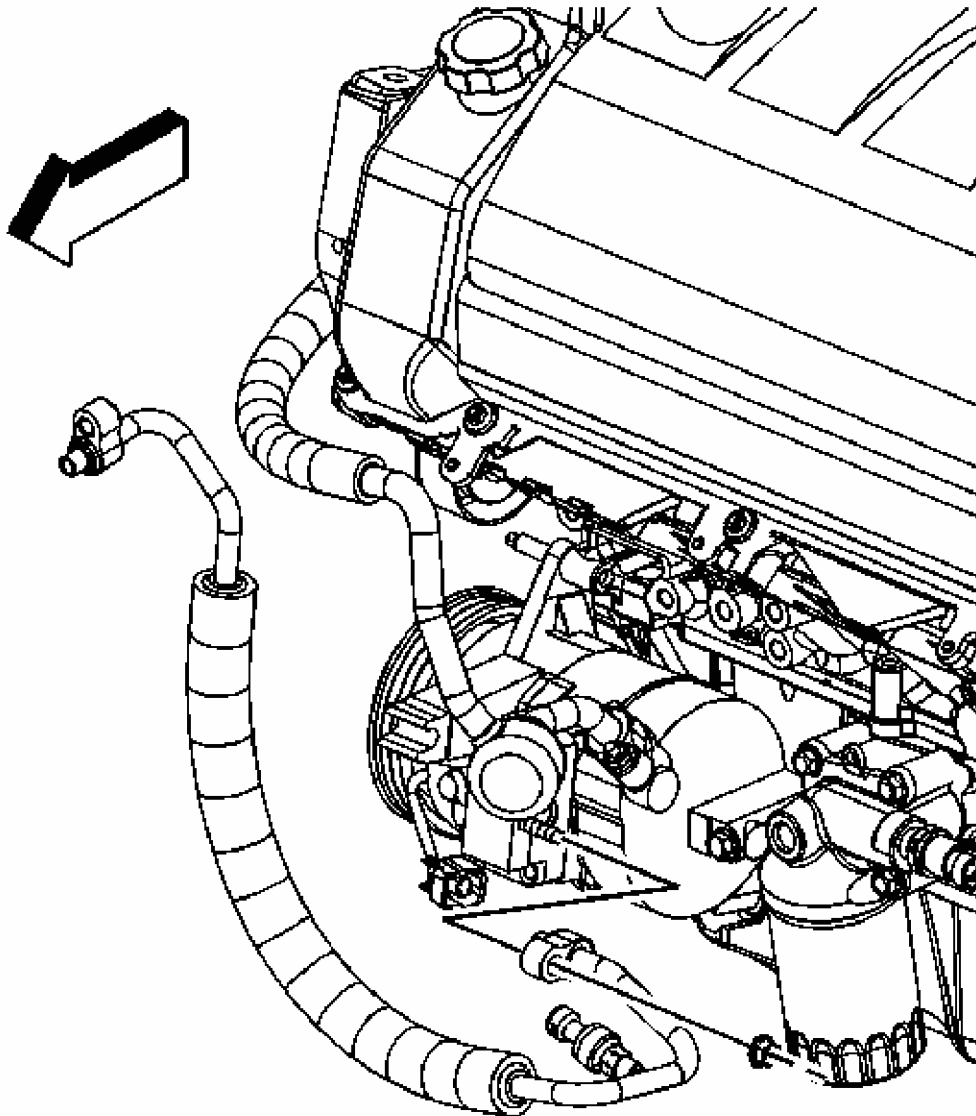


Fig. 113: View Of A/C Compressor Discharge Hose
Courtesy of GENERAL MOTORS CORP.

28. Remove the plug from the A/C compressor discharge port.
29. Remove and discard the old sealing washer from the compressor end of the discharge hose.

30. Install a NEW sealing washer to the compressor end of the discharge hose.
31. Install the A/C compressor discharge hose the compressor.
32. Install the A/C compressor discharge hose nut at the compressor.

Tighten: Tighten the nut to 16 N.m (12 lb ft).

33. Secure the discharge hose to the engine.

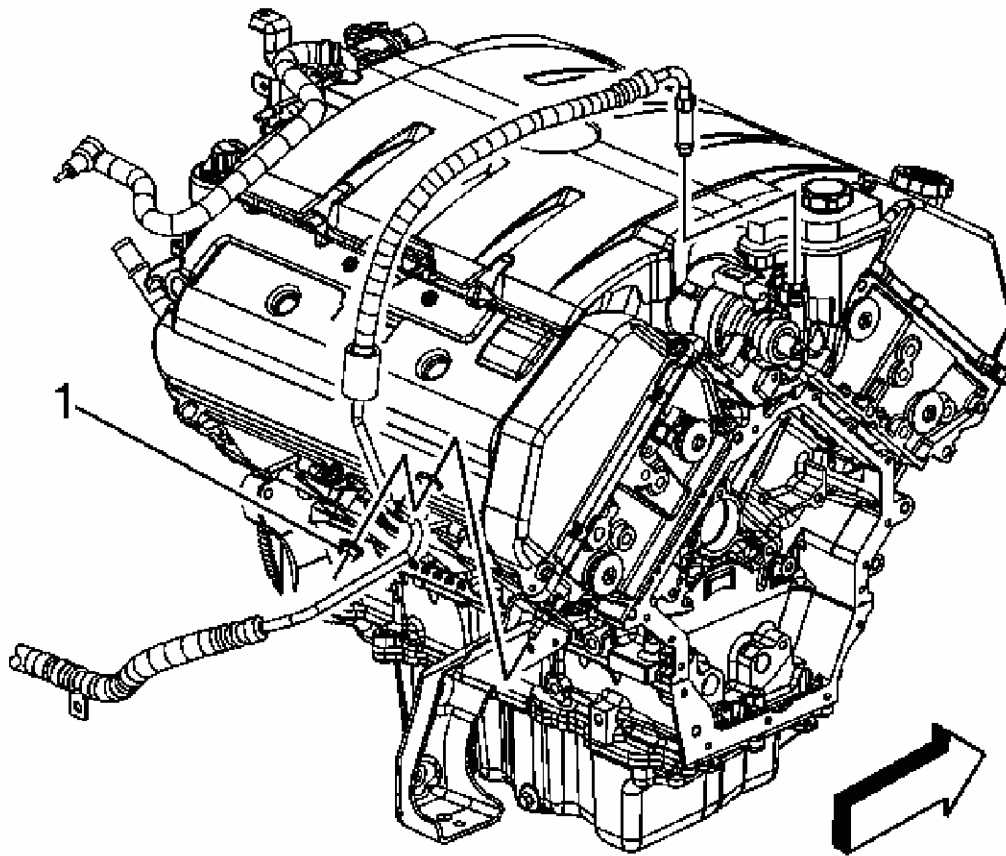


Fig. 114: Identifying Power Steering Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

34. Install the power steering inlet pipe fitting to the power steering pump.

Tighten: Tighten the fitting to 27 N.m (20 lb ft).

35. Install the power steering inlet pipe bracket to the stud.
36. Install the power steering inlet pipe nut (1) to the rear engine mount bracket stud.

Tighten: Tighten the nut to 9 N.m (80 lb in).

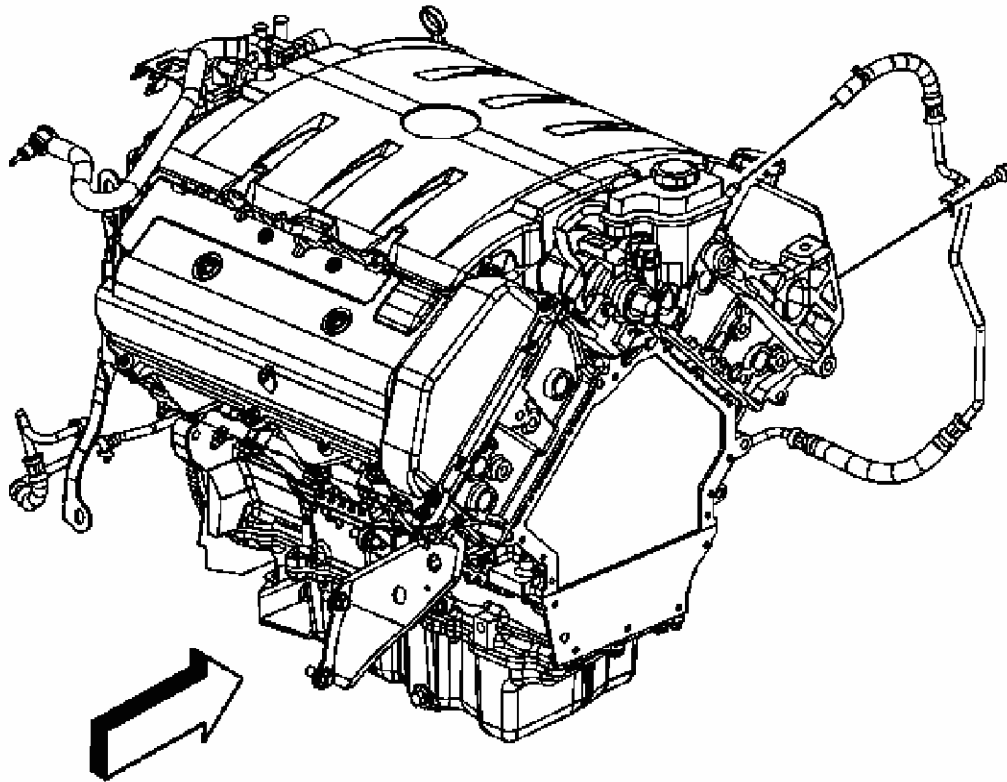


Fig. 115: Identifying Power Steering Outlet Hose
Courtesy of GENERAL MOTORS CORP.

37. Install the power steering outlet hose to the reservoir.
38. Position the power steering outlet hose clamp at the pump reservoir.
39. Install the power steering outlet pipe bolt to the engine mount strut bracket.

Tighten: Tighten the bolt to 9 N.m (80 lb in).

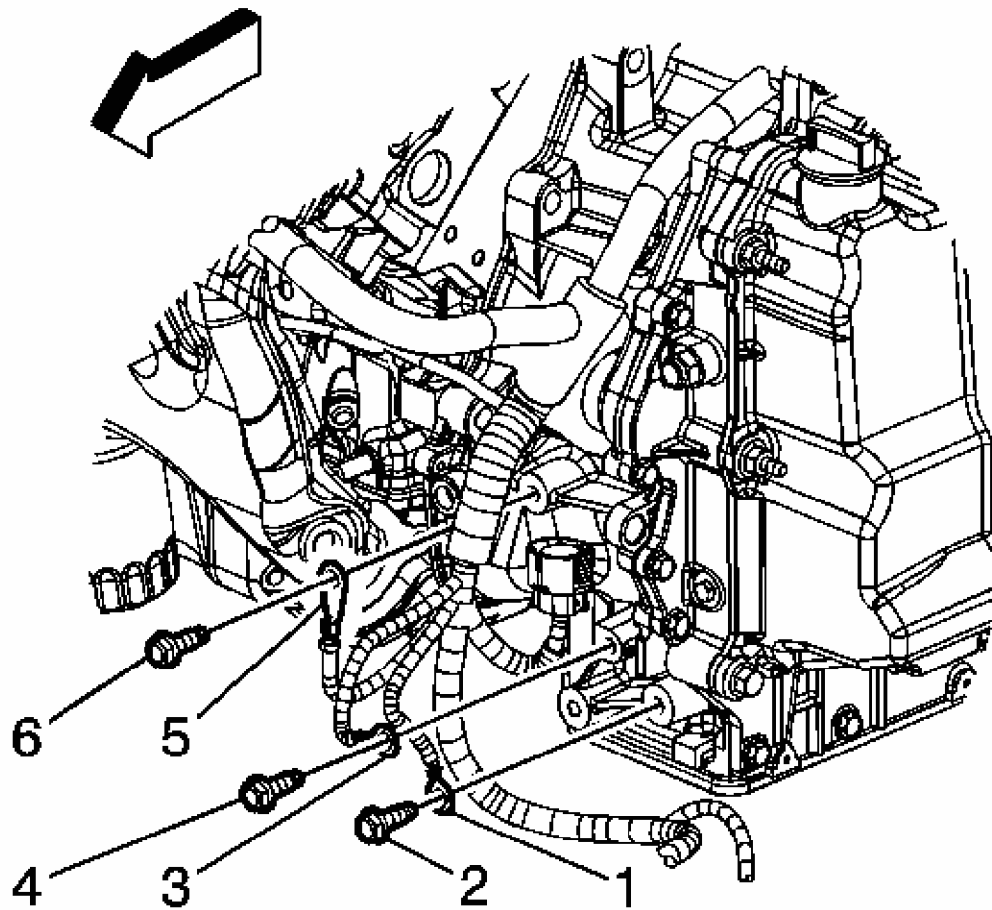


Fig. 116: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

40. Install the engine harness to the engine.
41. Position the engine harness grounds (1, 3 and 5) to the engine block.
42. Install the engine harness ground bolts (2, 4 and 6).

Tighten: Tighten the bolts to 25 N.m (18 lb ft).

43. Connect the engine harness electrical connector to the transaxle.

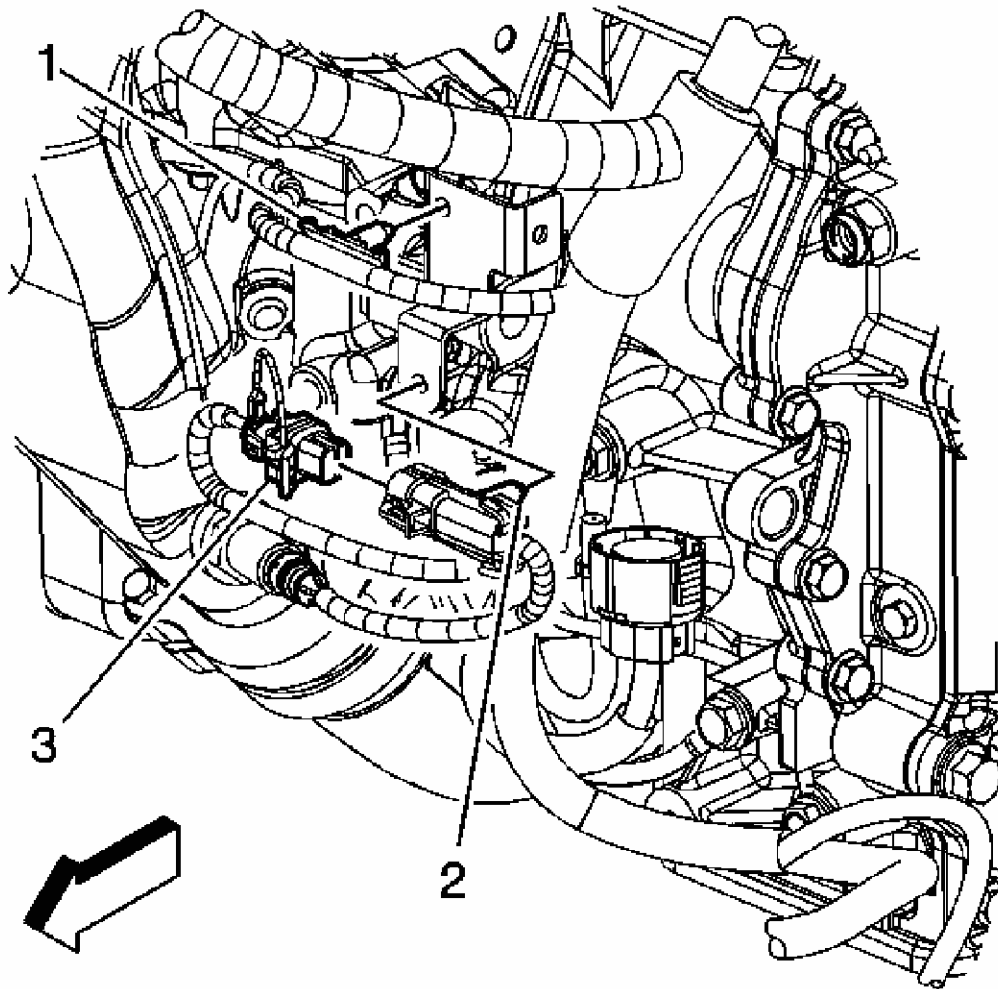


Fig. 117: View Of Engine Harness Electrical Connector & Clips
Courtesy of GENERAL MOTORS CORP.

44. Connect the engine harness electrical connector (3) to the HO2S.
45. Install the CPA retainer.
46. Install the engine harness clip (1) to the engine bracket.

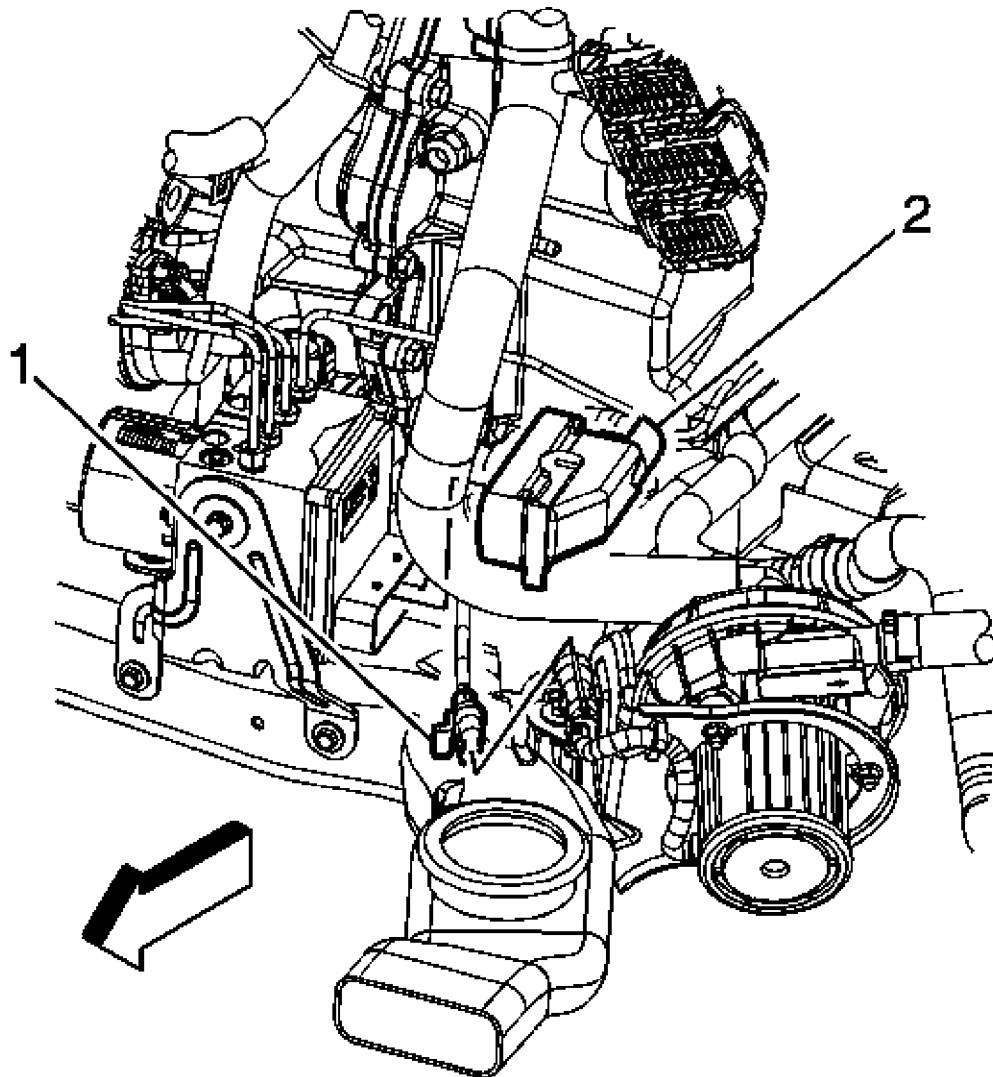


Fig. 118: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

47. Connect the engine harness electrical connectors to the following:
- The AIR pump (1)
 - The brake modulator (2)

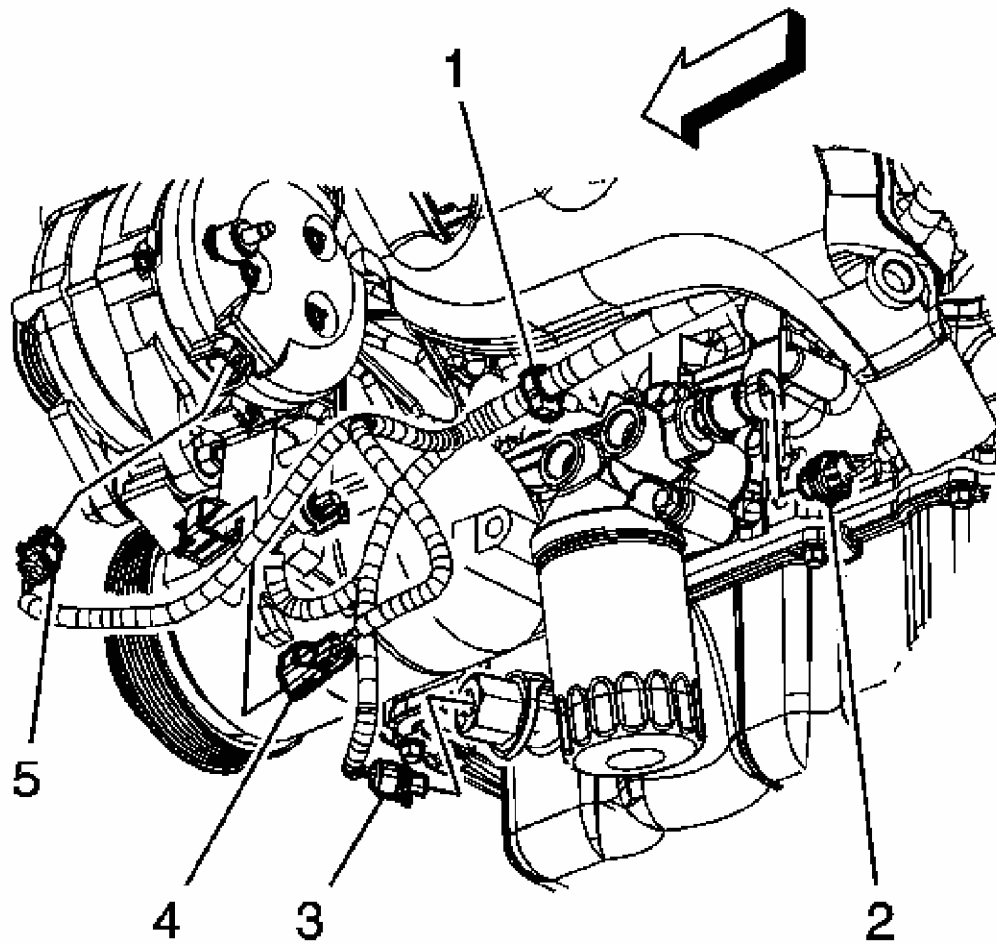


Fig. 119: Disconnecting/Connecting Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

48. Install the engine harness clip (1) to the boss on the engine block.
49. Connect the following engine harness electrical connectors:
 - The oil pressure sensor (2)
 - The oil level sensor (3)
 - The A/C compressor (4)
 - The generator (5)

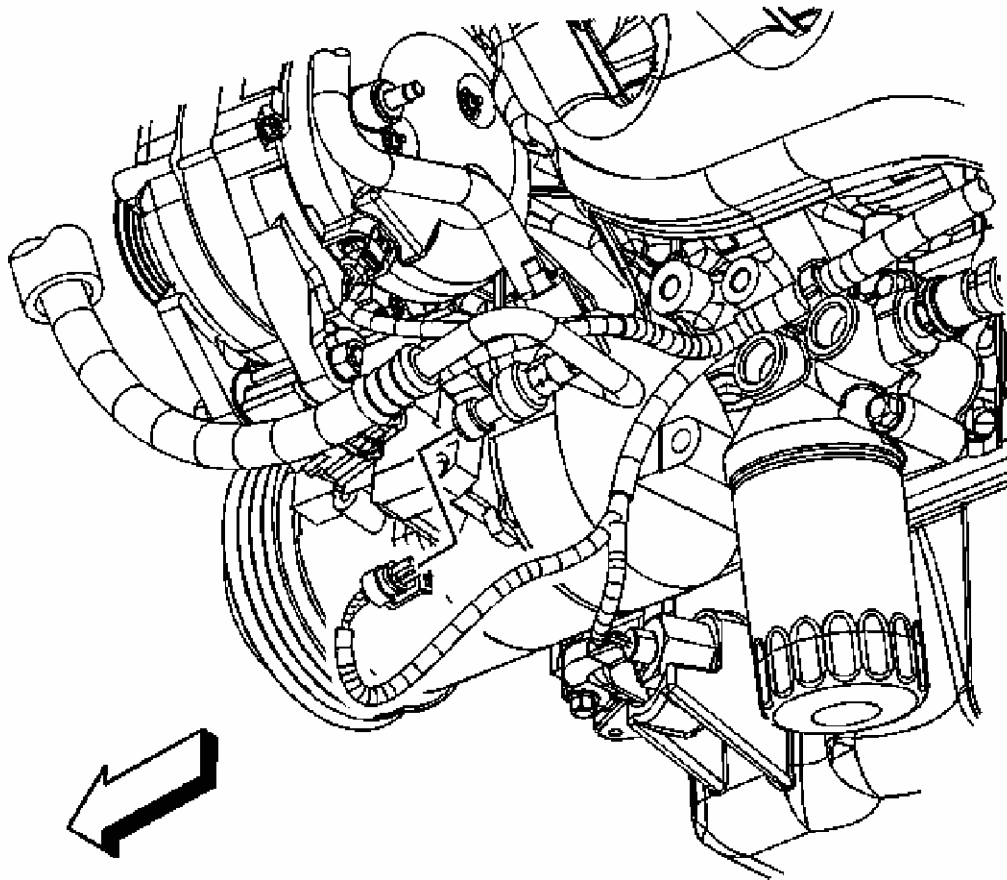


Fig. 120: Locating Engine Harness Electrical A/C Connector
Courtesy of GENERAL MOTORS CORP.

50. Connect the engine harness electrical connector to the A/C pressure sensor.

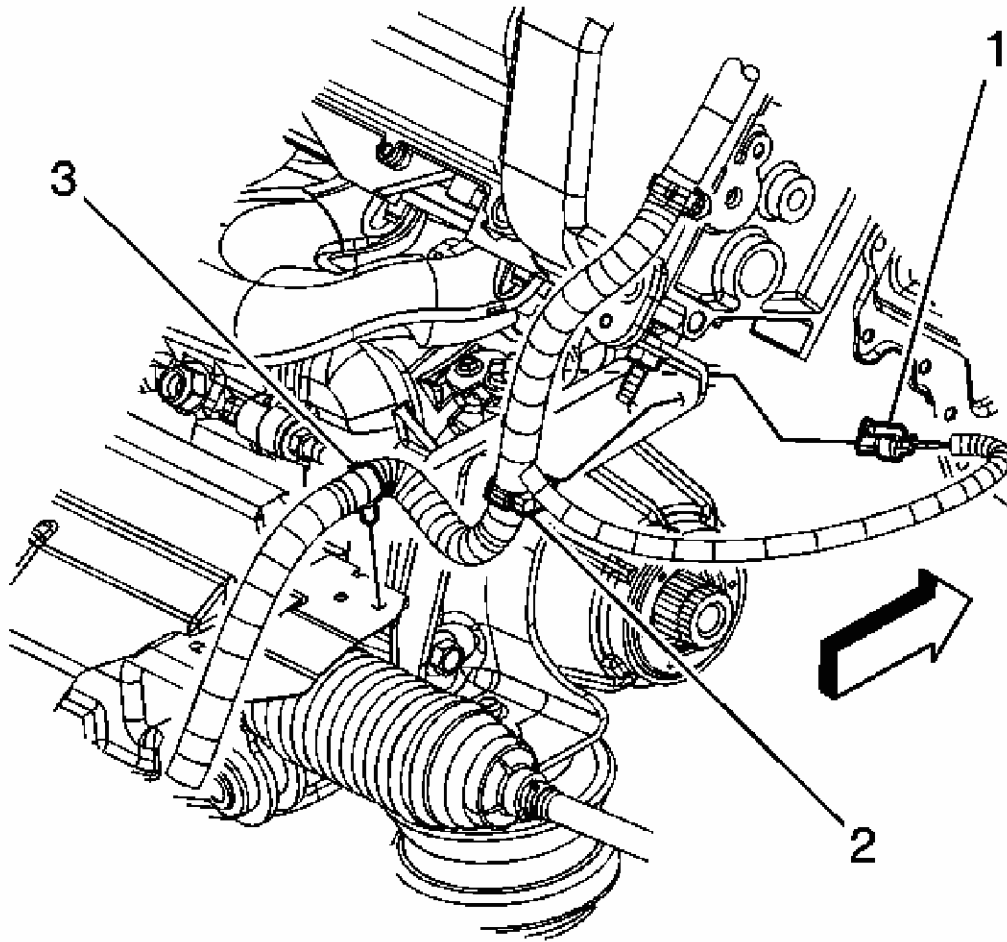


Fig. 121: Disconnecting/Connecting Engine Harness Clip At Steering Gear Heat Shield

Courtesy of GENERAL MOTORS CORP.

51. Connect the engine harness electrical connector (1) to the VSS.
52. Install the engine harness clips (2, 3) to the rear engine mount bracket and steering gear shield.

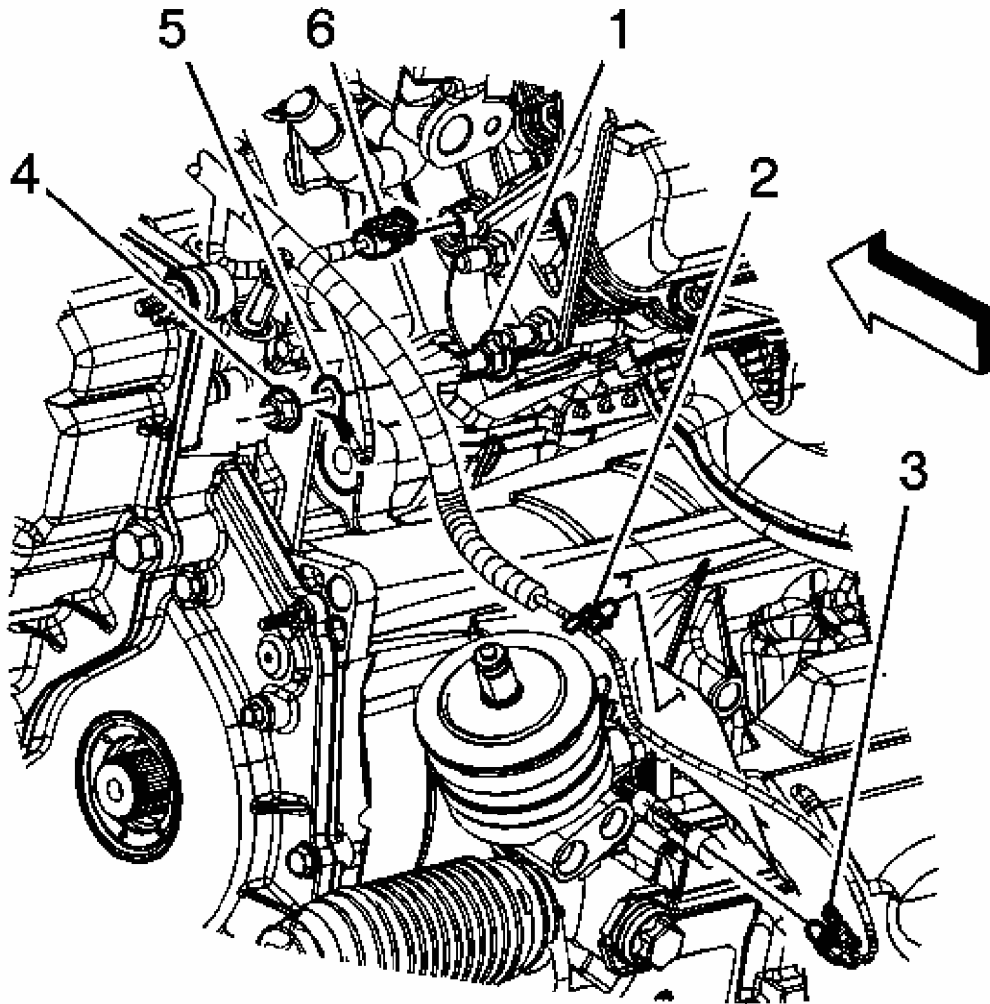


Fig. 122: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

- 53. Connect the engine harness electrical connector (6) to the ECT sensor.
- 54. Install the engine harness ground (5) to the stud.
- 55. Install the engine harness ground nut (4).

Tighten: Tighten the bolt to 25 N.m (18 lb ft).

- 56. Install the engine harness clip (2) to the steering gear shield.
- 57. Connect the engine harness electrical connector (3) to the power steering sensor.

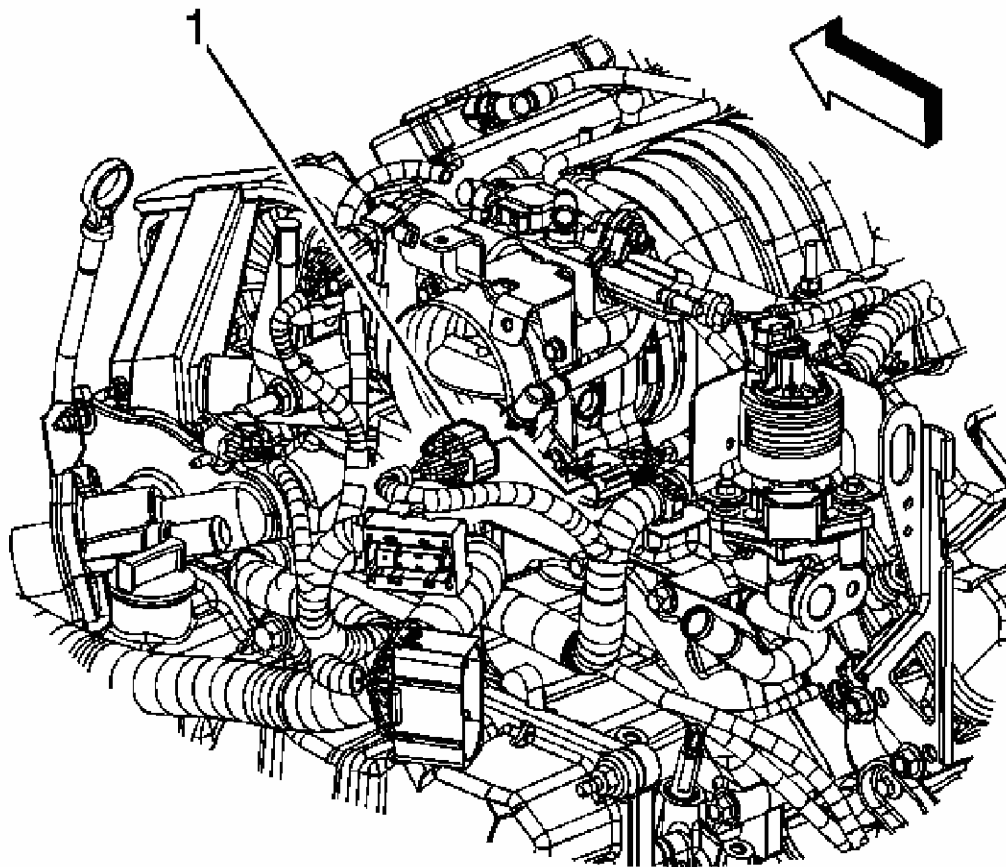


Fig. 123: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

58. Connect the engine harness electrical connector (1) to the engine valley jumper harness electrical connector.

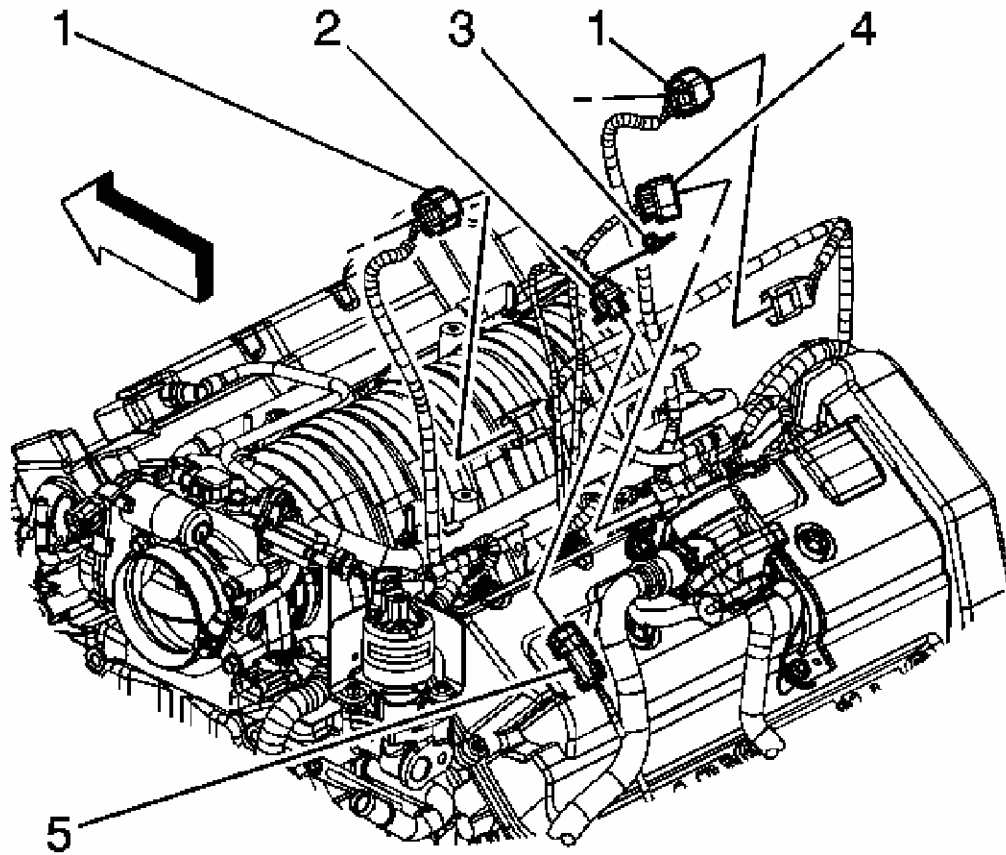


Fig. 124: Identifying Engine Harness Electrical Connector To Starter Solenoid
Courtesy of GENERAL MOTORS CORP.

59. Connect the following engine harness electrical connectors to the top of the engine:
- The starter inline (1)
 - The AIR check valve (4)

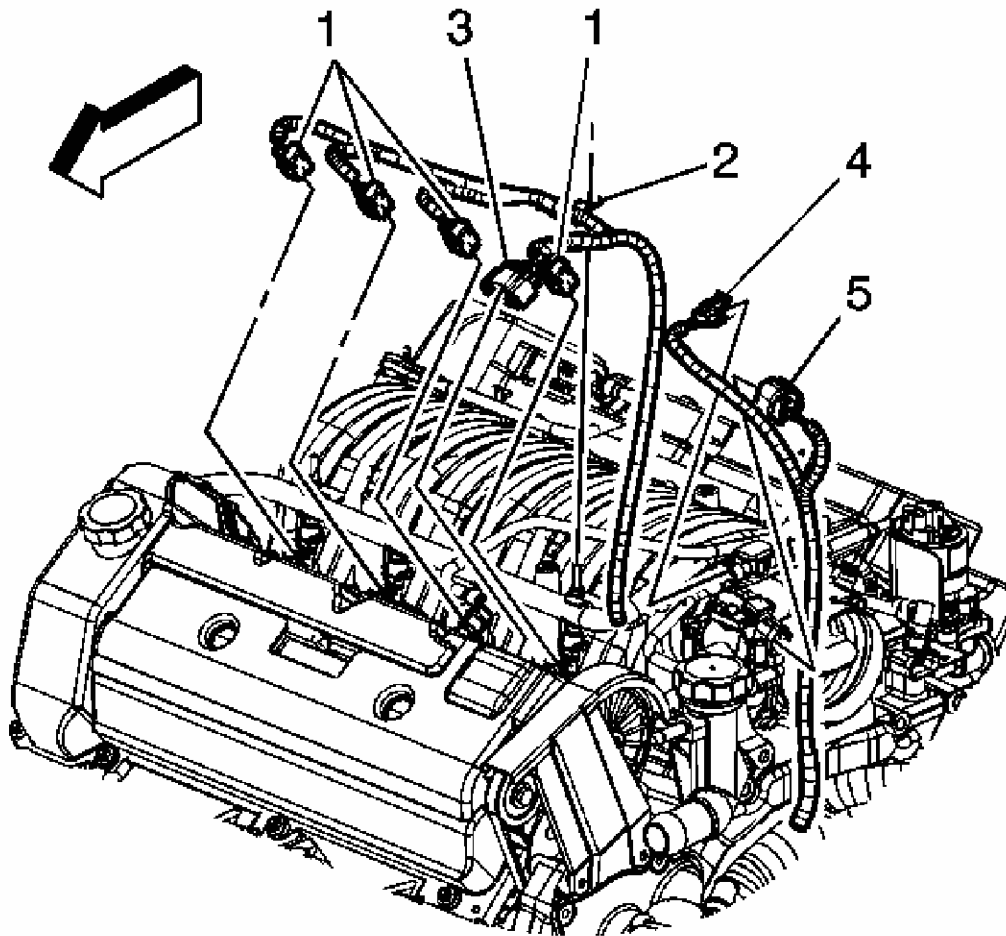


Fig. 125: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

60. Connect the following engine harness electrical connectors to the front of the engine:
 - The fuel injectors (1)
 - The ICM (3)
 - The MAP sensor (4)
 - the throttle actuator (5)
61. Install the engine harness clip (2) to the fuel rail stud.

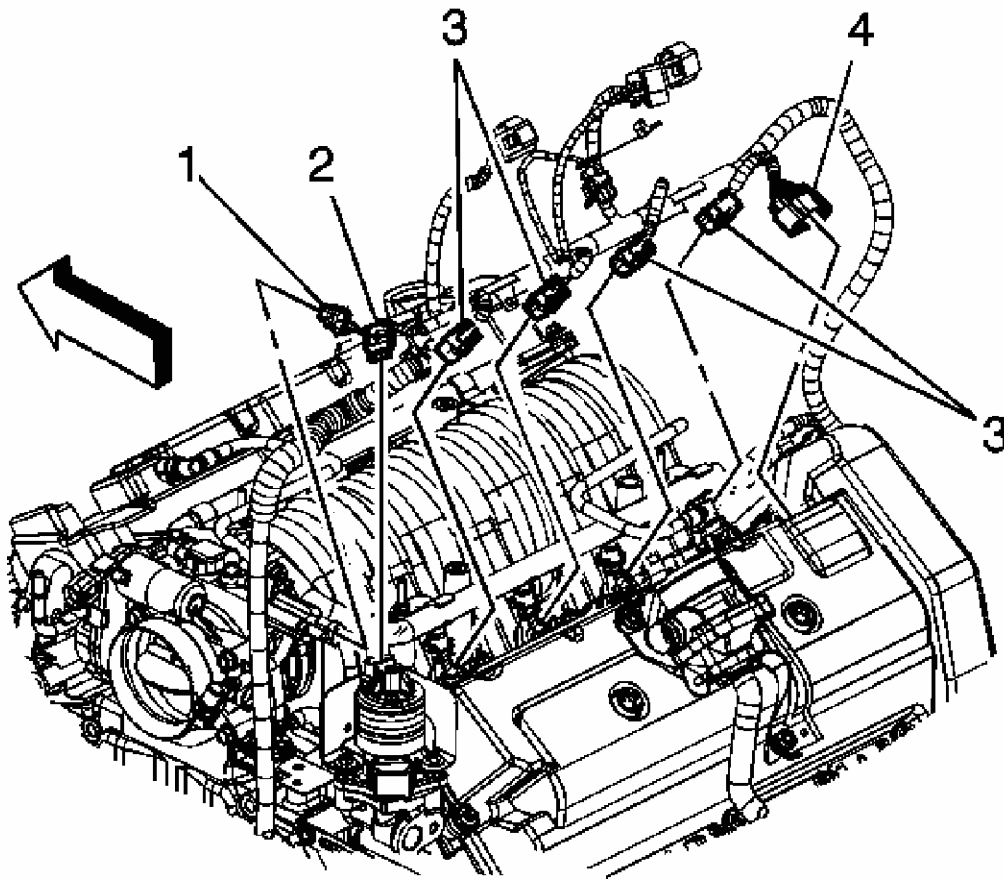


Fig. 126: Locating Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

62. Connect the following engine harness electrical connectors to the rear of the engine:
- The EVAP solenoid (1)
 - The EGR valve (2)
 - The fuel injectors (3)
 - The ICM (4)

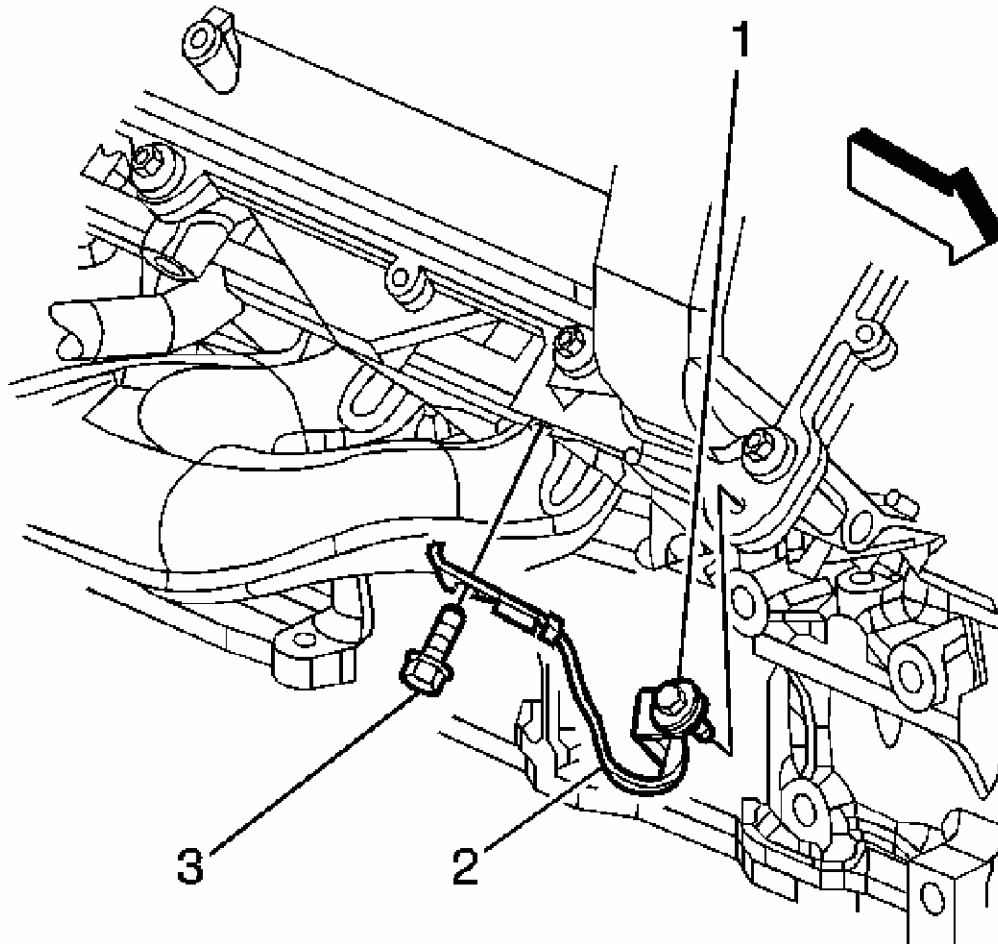


Fig. 127: Locating ICM Ground Strap & Bolt
Courtesy of GENERAL MOTORS CORP.

63. Position the ICM ground strap (2) to the cylinder head.
64. Install the ICM ground strap bolt (3) to the right cylinder head.

Tighten: Tighten the bolt to 25 N.m (18 lb ft).

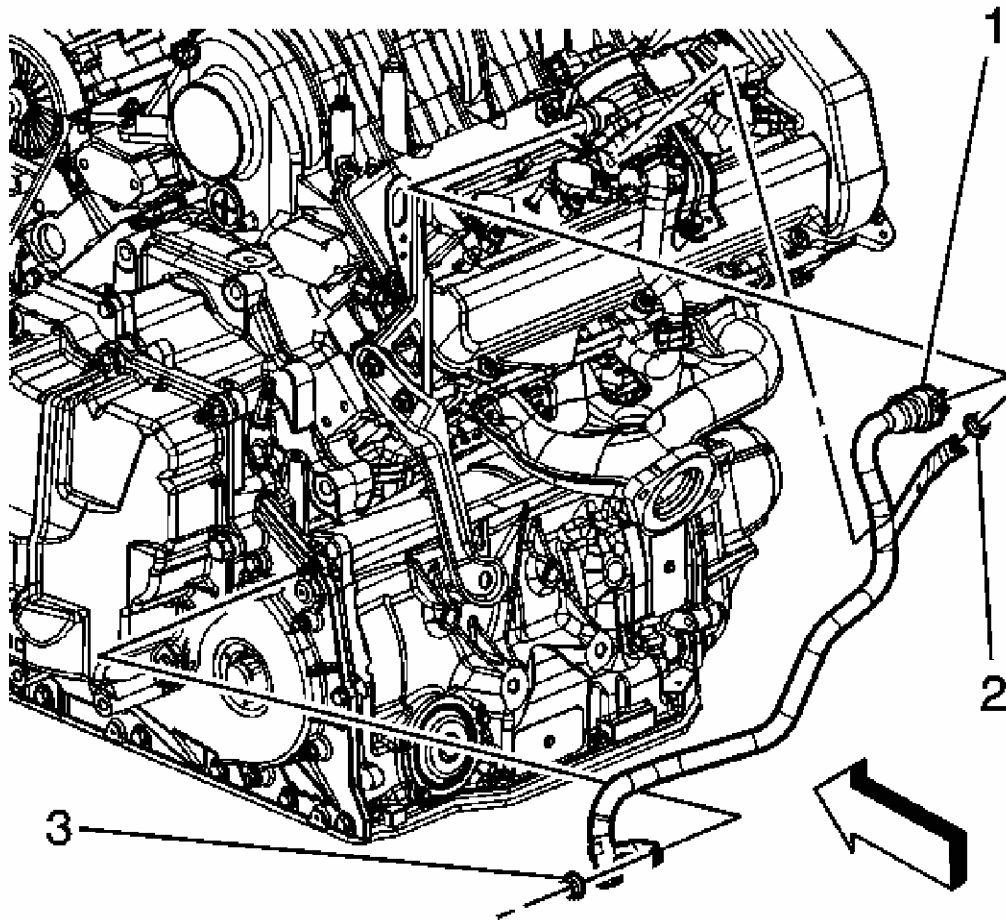


Fig. 128: View Of AIR Pipe Outlet Pipe
Courtesy of GENERAL MOTORS CORP.

65. Install the AIR pipe over the studs.
66. Connect the AIR outlet pipe quick connect fitting to the check valve. Refer to **Plastic Collar Quick Connect Fitting Service**.
67. Install the AIR pipe outlet pipe nut (2) to the check valve bracket stud.

Tighten: Tighten the nut to 9 N.m (80 lb in).

68. Install the AIR pipe outlet pipe nut (3) to the transaxle stud.

Tighten: Tighten the nut to 9 N.m (80 lb in).

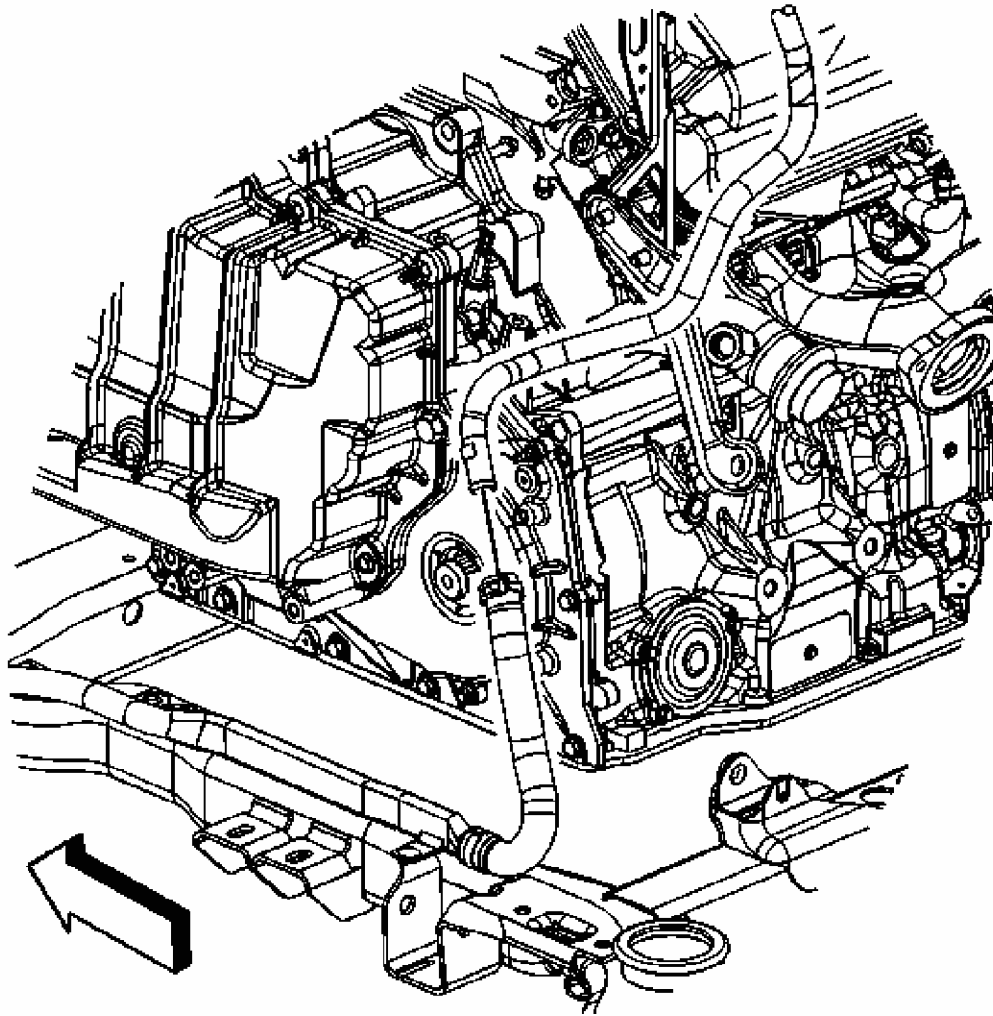


Fig. 129: View Of AIR Outlet Hose
Courtesy of GENERAL MOTORS CORP.

69. Connect the AIR outlet hose to the AIR outlet pipe.
70. Position the AIR outlet hose clamp at the AIR outlet pipe.

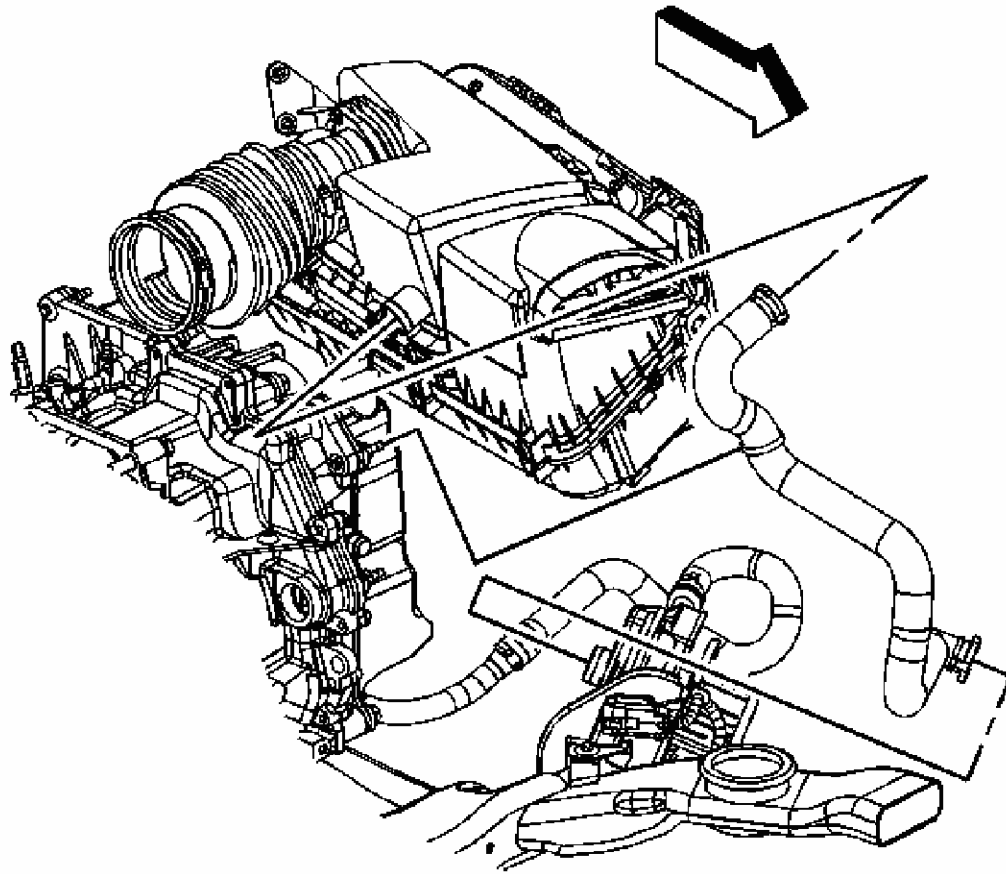


Fig. 130: Identifying Secondary AIR Pump Inlet Tube/Hose
Courtesy of GENERAL MOTORS CORP.

71. Install the AIR inlet hose.
72. Connect the AIR inlet hose quick connect fitting to the AIR pump. Refer to **Plastic Collar Quick Connect Fitting Service**.
73. Install the AIR inlet hose retainer to the transaxle stud.

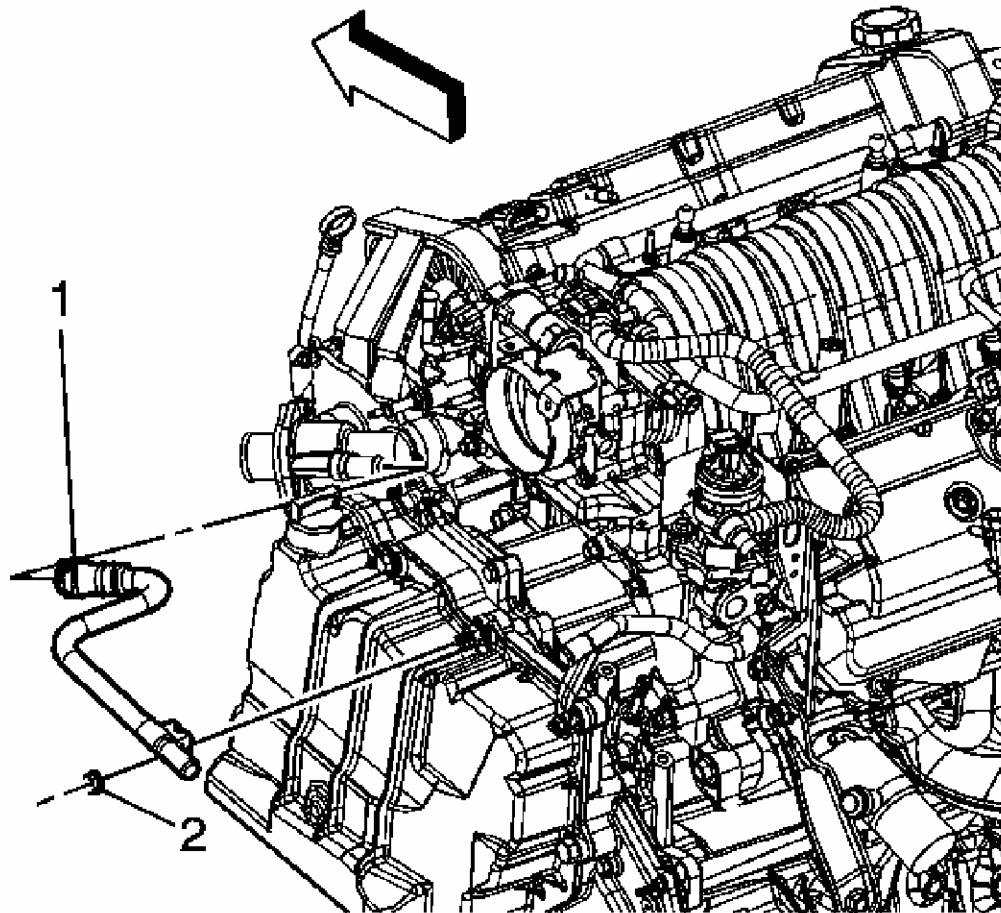


Fig. 131: Identifying Heater Outlet Pipe
Courtesy of GENERAL MOTORS CORP.

74. Install the heater outlet pipe to the engine and stud.
75. Install the heater outlet pipe nut (2) to the transaxle stud.

Tighten: Tighten the nut to 25 N.m (18 lb ft).

76. Position the heater outlet pipe clamp (1) at the water pump housing.

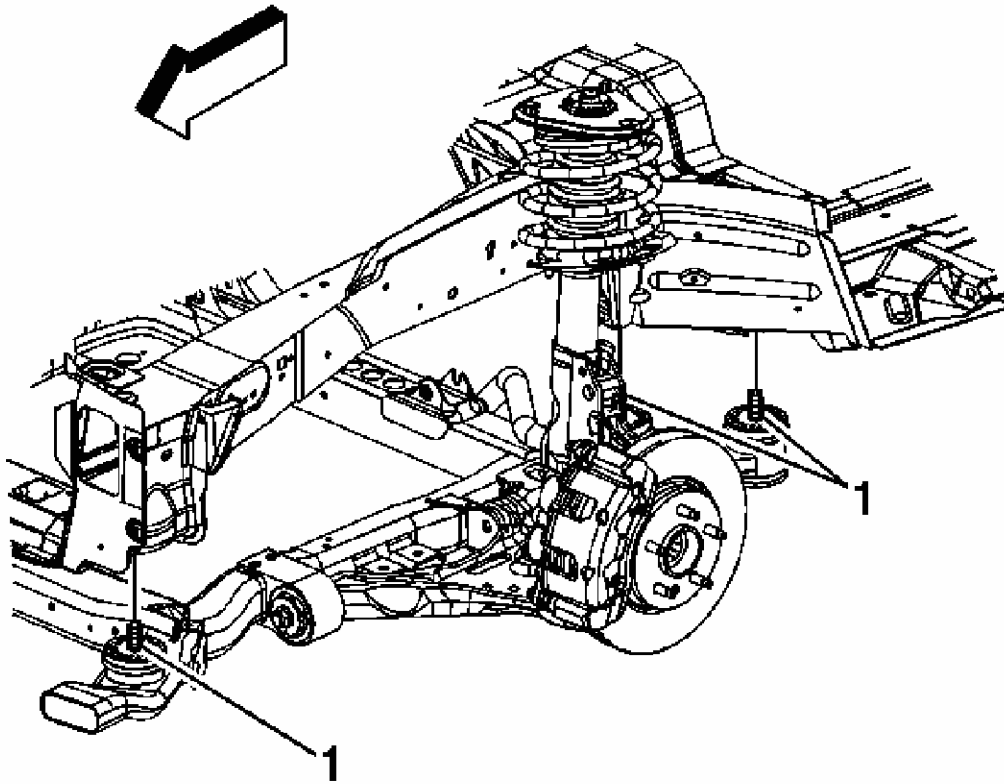


Fig. 132: Identifying Rearward Engine Frame-To-Body Bolts
Courtesy of GENERAL MOTORS CORP.

77. Position the engine/transaxle assembly under the vehicle.

IMPORTANT: Ensure clearance is maintained between the engine/transaxle assembly and the following:

- The A/C compressor components
- The brake pipes
- The heater hoses
- The radiator hoses
- The wheel speed sensor leads
- The wiring harnesses

78. Carefully lower the vehicle over the engine/transaxle assembly, aligning the struts to the strut towers.

79. Install the 6 bolts (1) attaching the frame to the body. (Left side shown, right side similar).

Tighten: Tighten the bolts to 191 N.m (141 lb ft).

80. Install the front fascia. Refer to **Front Bumper Fascia Replacement** .

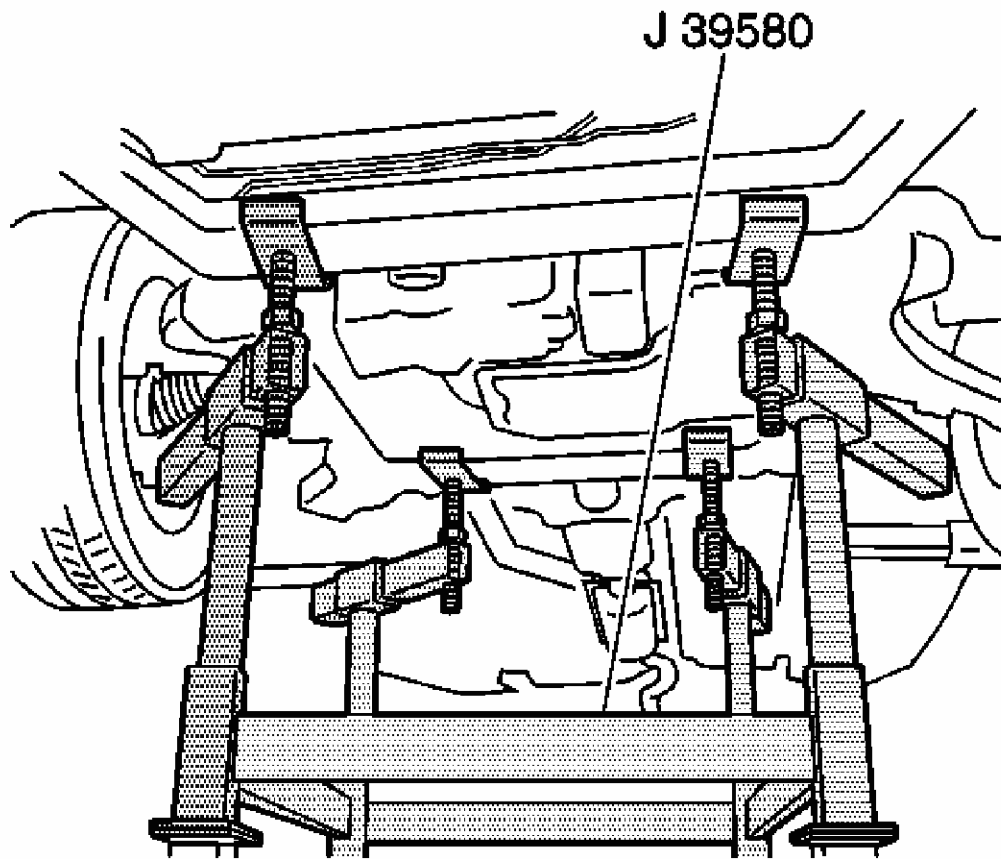


Fig. 133: Identifying Utility Stand
Courtesy of GENERAL MOTORS CORP.

81. Raise the vehicle off of the **J 39580** or the jack stands. See **Special Tools** .
82. Remove the **J 39580** or jack stands from under the frame. See **Special Tools** .
83. Align the flywheel with the marks made during the removal.

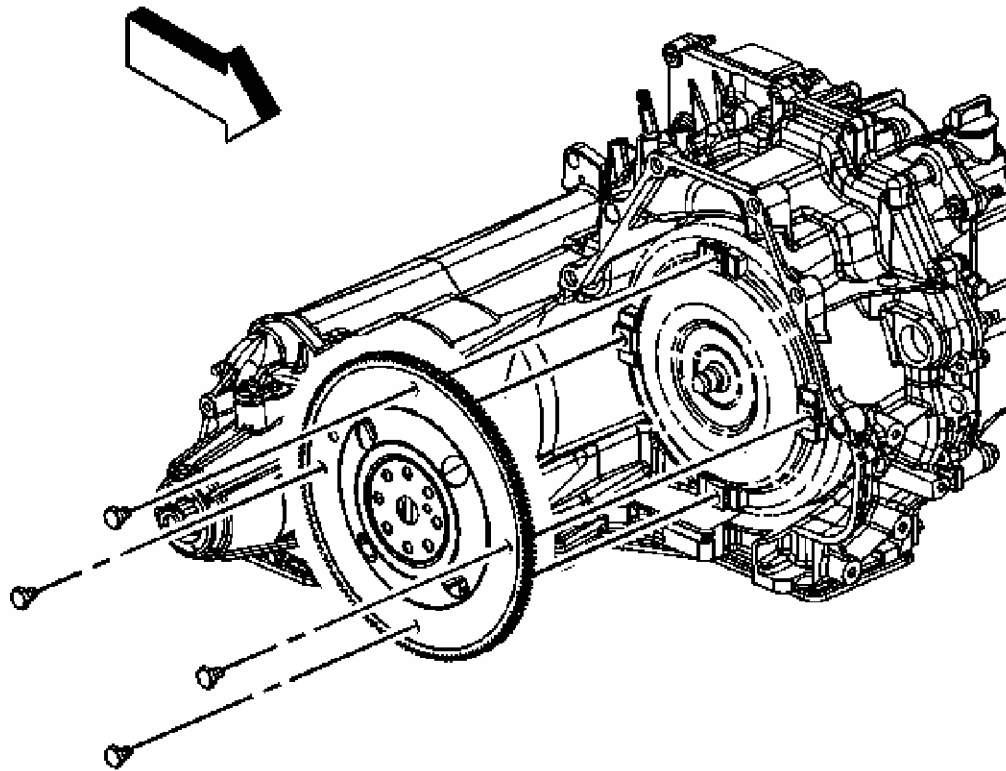


Fig. 134: Identifying Flywheel-To-Torque Converter Bolts
Courtesy of GENERAL MOTORS CORP.

84. Install the flywheel to torque converter bolts. (Engine removed for clarity).

Tighten: Tighten the bolts to 60 N.m (44 lb ft).

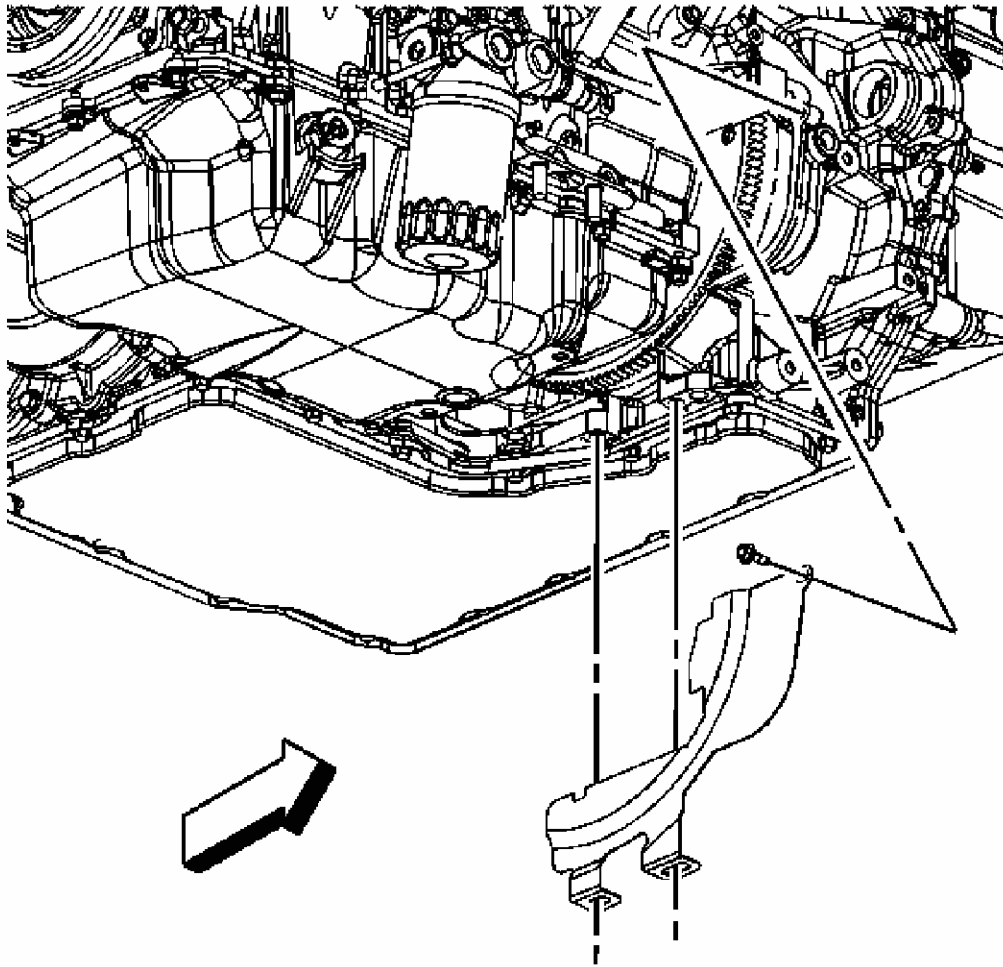


Fig. 135: View Of Torque Converter Cover
Courtesy of GENERAL MOTORS CORP.

85. Position the torque converter cover.
86. Install the torque converter cover bolt.

Tighten: Tighten the bolt to 12 N.m (106 lb in).

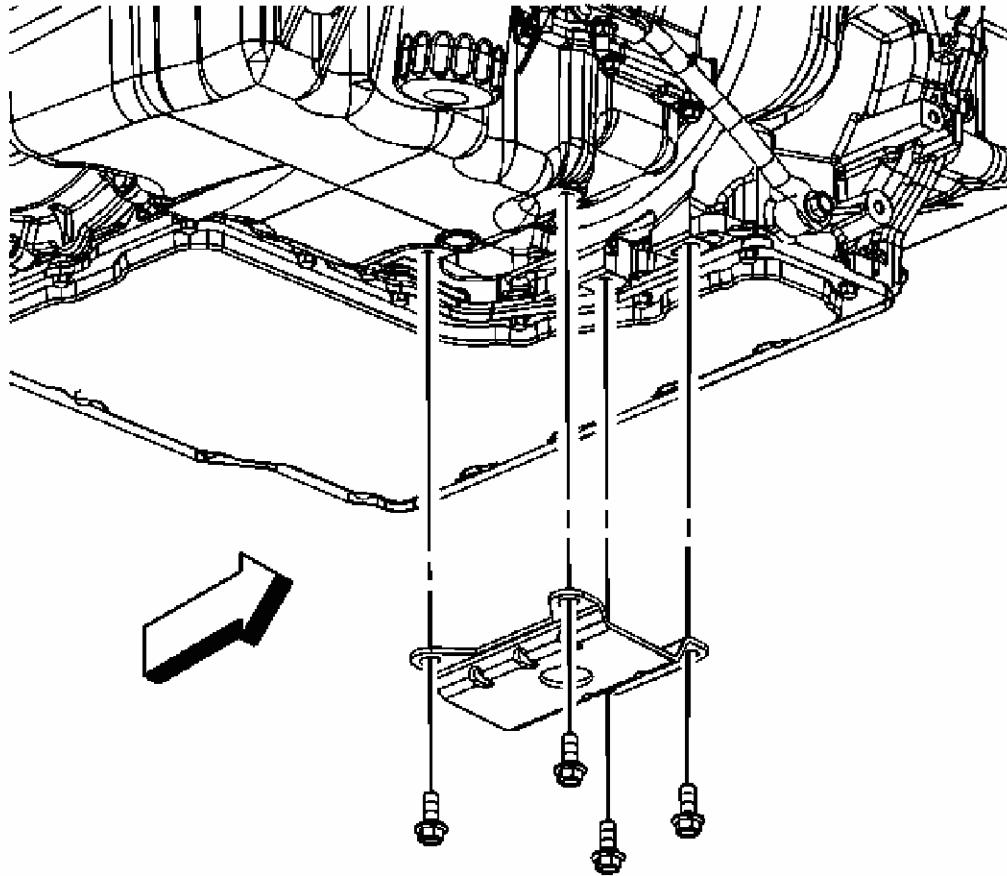


Fig. 136: Identifying Transaxle To Engine Brace Bolts
Courtesy of GENERAL MOTORS CORP.

87. Install the transaxle brace.
88. Install the transaxle brace bolts.

Tighten: Tighten the bolts to 47 N.m (35 lb ft).

89. Connect the engine harness electrical connector to the HO2S.

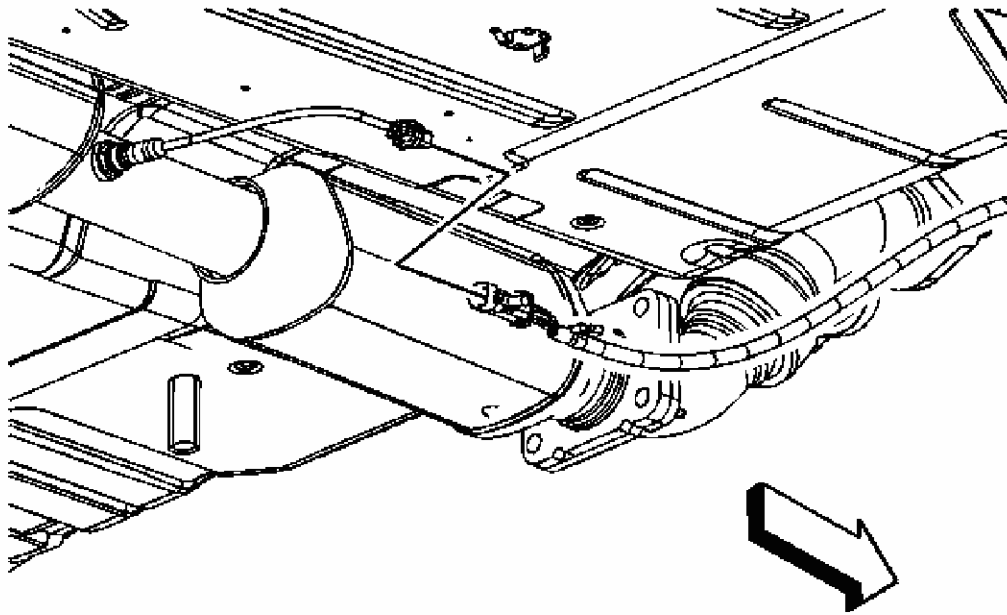


Fig. 137: Identifying Oxygen Sensor Wiring Harness Heat Shield
Courtesy of GENERAL MOTORS CORP.

90. Install the oxygen sensor wiring harness heat shield. Refer to **Oxygen Sensor Wiring Harness Heat Shield Replacement** .

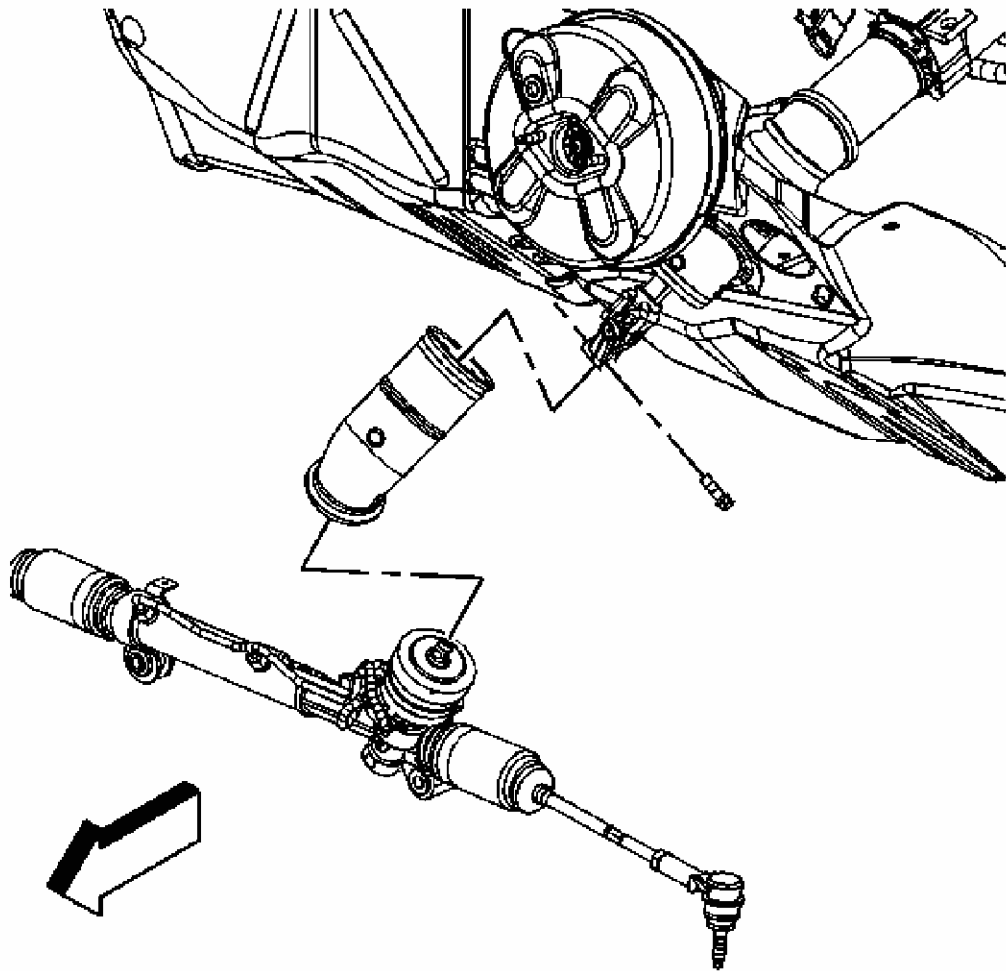


Fig. 138: Identifying Steering Gear & Related Attachments
Courtesy of GENERAL MOTORS CORP.

CAUTION: When installing the intermediate shaft make sure that the shaft is seated prior to pinch bolt installation. If the pinch bolt is inserted into the coupling before shaft installation, the two mating shafts may disengage. Disengagement of the two mating shafts will cause loss of steering control which could result in personal injury.

91. Install the intermediate shaft to the steering gear.
92. Install the intermediate shaft pinch bolt.

Tighten: Tighten the bolt to 45 N.m (33 lb ft).

93. Install the intermediate steering shaft cover.

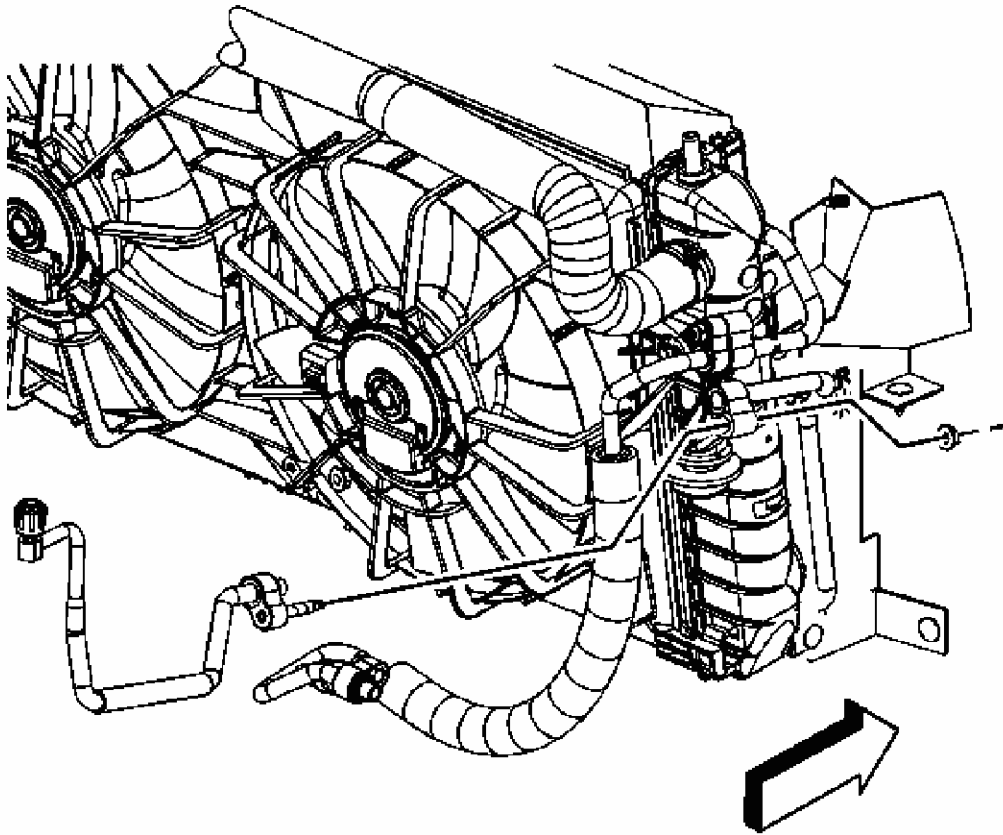


Fig. 139: View Of A/C Suction Hose & Condenser
Courtesy of GENERAL MOTORS CORP.

94. Remove the plug from the A/C condenser suction port.
95. Unsecure the A/C compressor suction hose from the engine.
96. Remove and discard the old sealing washer from the condenser end of the suction hose.
97. Install a NEW sealing washer to the condenser end of the suction hose.
98. Install the A/C compressor suction hose to the condenser.
99. Install the A/C compressor suction hose nut.

Tighten: Tighten the nut to 16 N.m (12 lb ft).

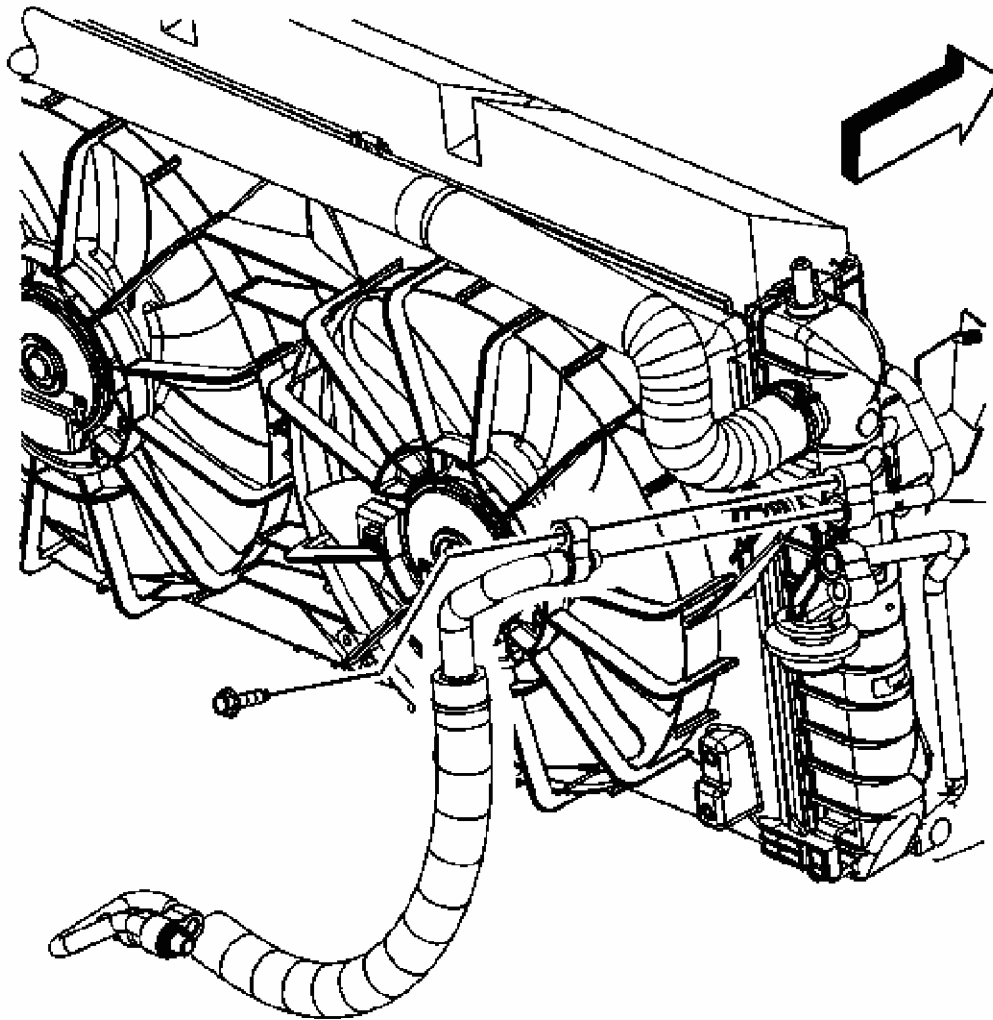


Fig. 140: View Of A/C Discharge Hose & Condenser
Courtesy of GENERAL MOTORS CORP.

- 100. Remove the plug from the A/C condenser discharge port.
- 101. Unsecure the A/C compressor discharge hose from the engine.
- 102. Remove and discard the old sealing washer from the condenser end of the discharge hose.
- 103. Install a NEW sealing washer to the condenser end of the discharge hose.
- 104. Install the A/C compressor discharge hose to the condenser.
- 105. Install the A/C compressor discharge hose nut.

Tighten: Tighten the nut to 16 N.m (12 lb ft).

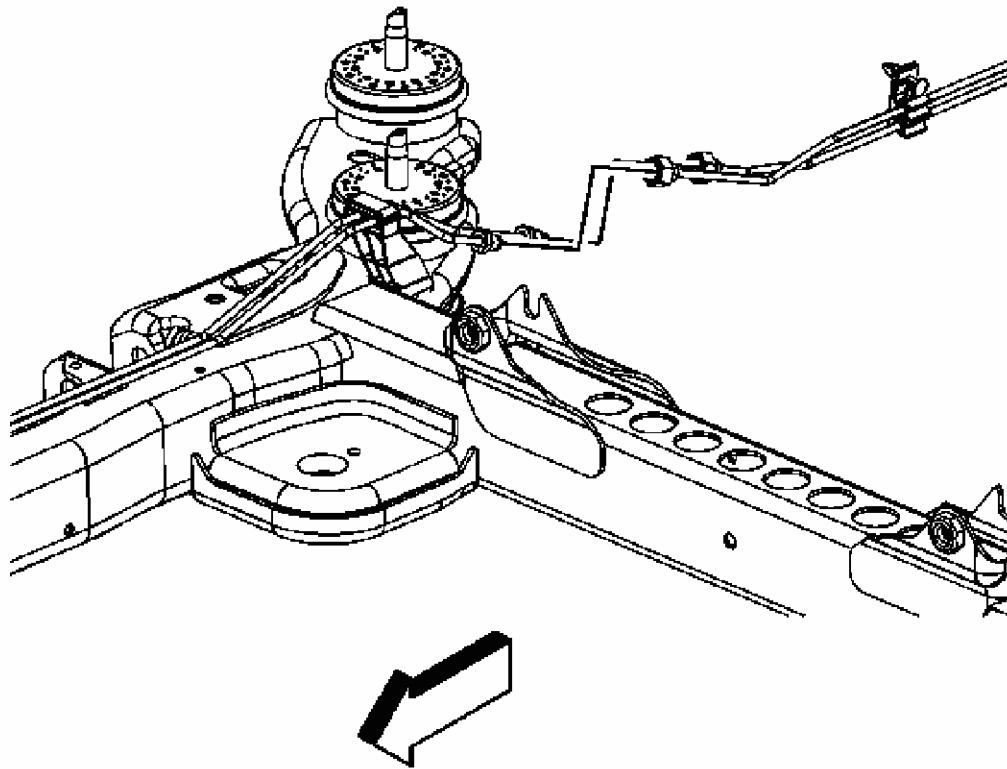


Fig. 141: Identifying Rear Brake Pipes/Lines
Courtesy of GENERAL MOTORS CORP.

- 106. Remove the plugs from the open brake lines.
- 107. Connect the rear brake pipes to the front brake pipes.

Tighten: Tighten the fittings to 20 N.m (15 lb ft).

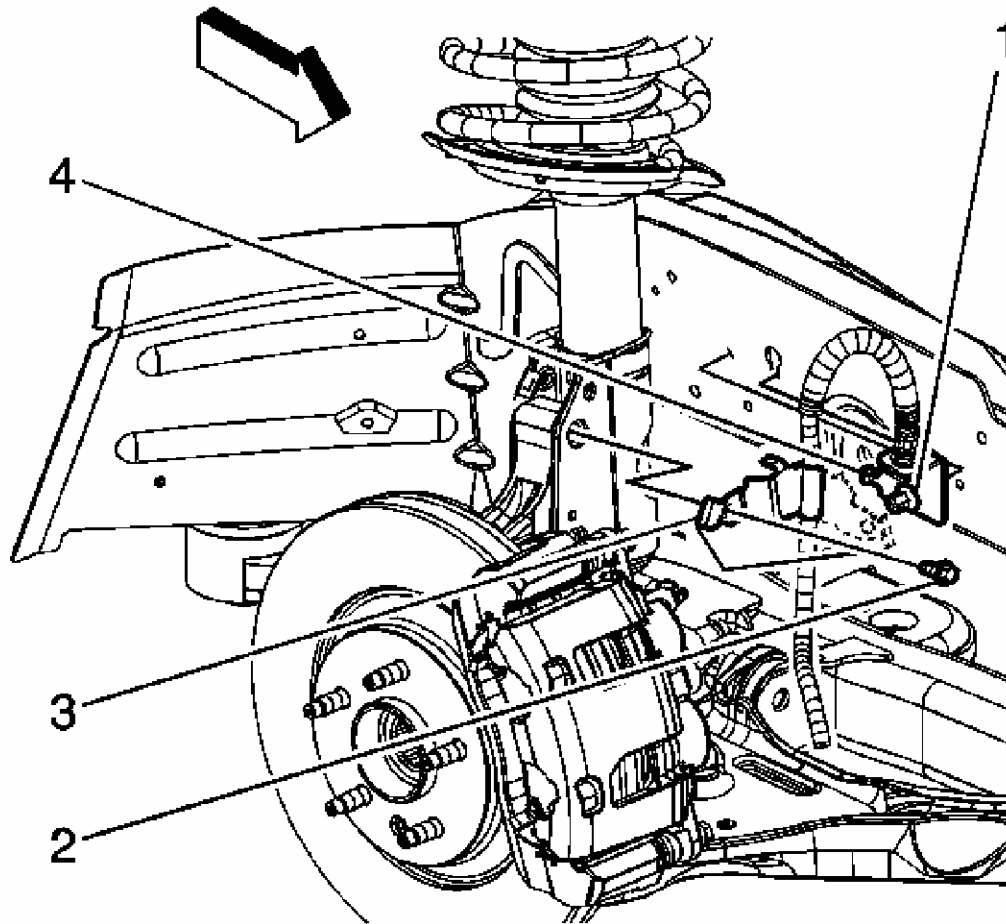


Fig. 142: Identifying Front Brake Pipe Bracket
Courtesy of GENERAL MOTORS CORP.

- 108. Install the front brake pipe bracket (4) to the body frame rail.
- 109. Tighten the nut (1) securing the right front brake pipe bracket (4) to the body frame rail.

Tighten: Tighten the nut to 9 N.m (80 lb in).

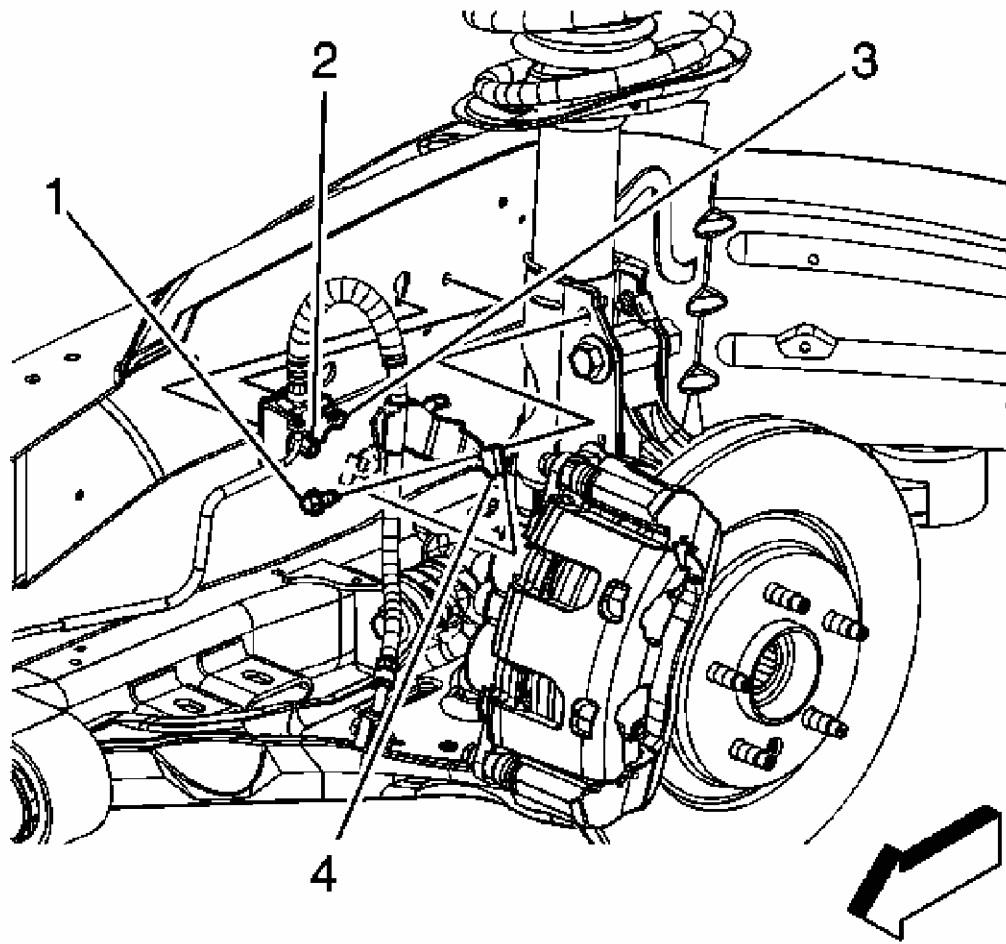


Fig. 143: Identifying Front Brake Pipe Bracket
Courtesy of GENERAL MOTORS CORP.

- l 10. Install the front brake pipe bracket (4) to the body frame rail.
- l 11. Tighten the nut (2) securing the left front brake pipe bracket (4) to the body frame rail.

Tighten: Tighten the nut to 9 N.m (80 lb in).

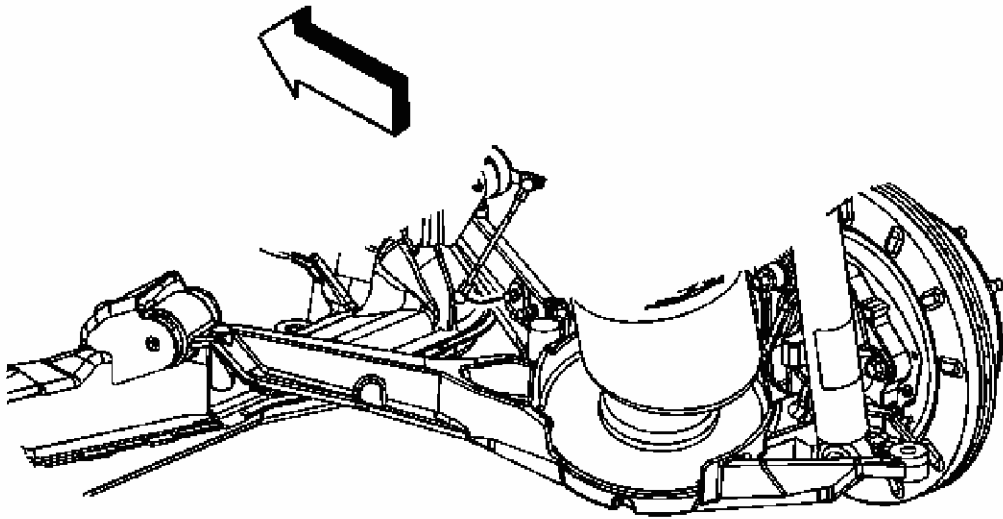


Fig. 144: Identifying Electronic Suspension Front Position Sensor Link
Courtesy of GENERAL MOTORS CORP.

- | 12. Install the front air deflector. Refer to **Front Air Deflector Replacement** .
- | 13. Connect the electronic suspension front position sensor link to the lower control arms ball stud, if equipped.

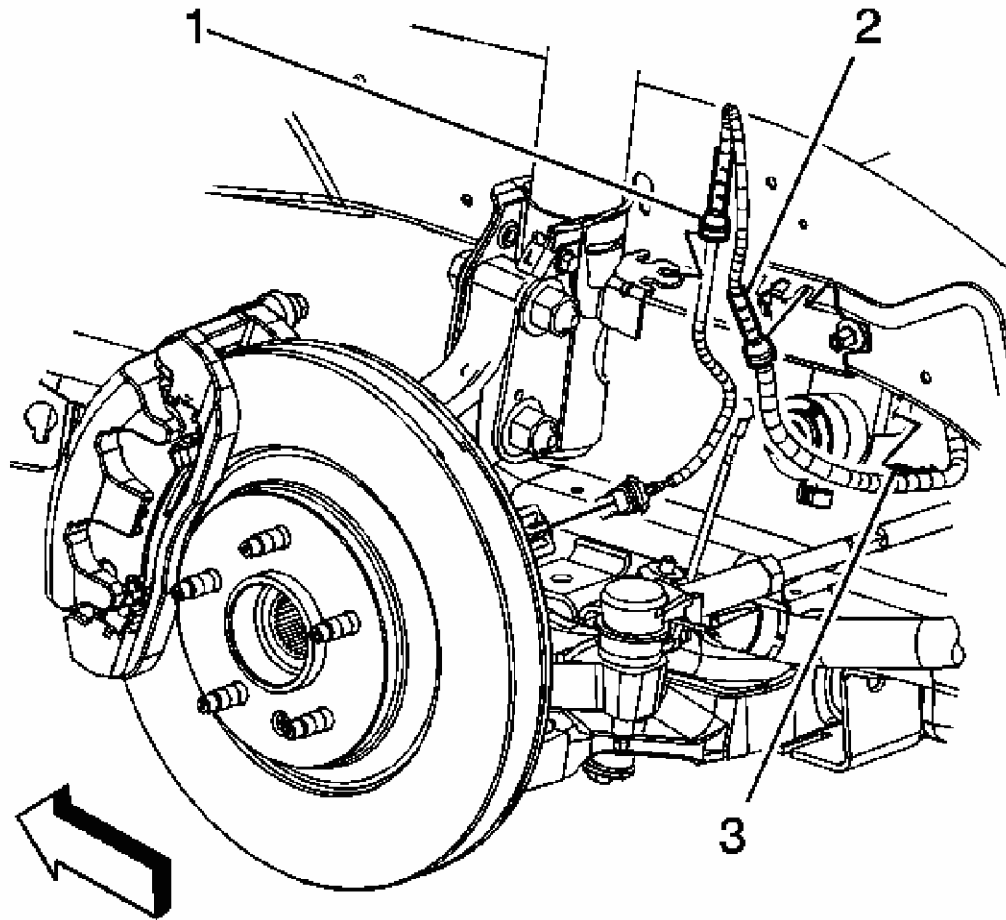


Fig. 145: Identifying Engine Harness Grommets & Clips
Courtesy of GENERAL MOTORS CORP.

- l14. Install the engine harness clip (3) to the ride lever sensor bracket.
- l15. Install the engine harness grommet (2) to the frame rail bracket.
- l16. Install the front wheels. Refer to **Tire and Wheel Removal and Installation**.
- l17. Install the rear exhaust manifold pipe. Refer to **Exhaust Manifold Rear Pipe Replacement (RPO LD8)**.
- l18. Lower the vehicle.

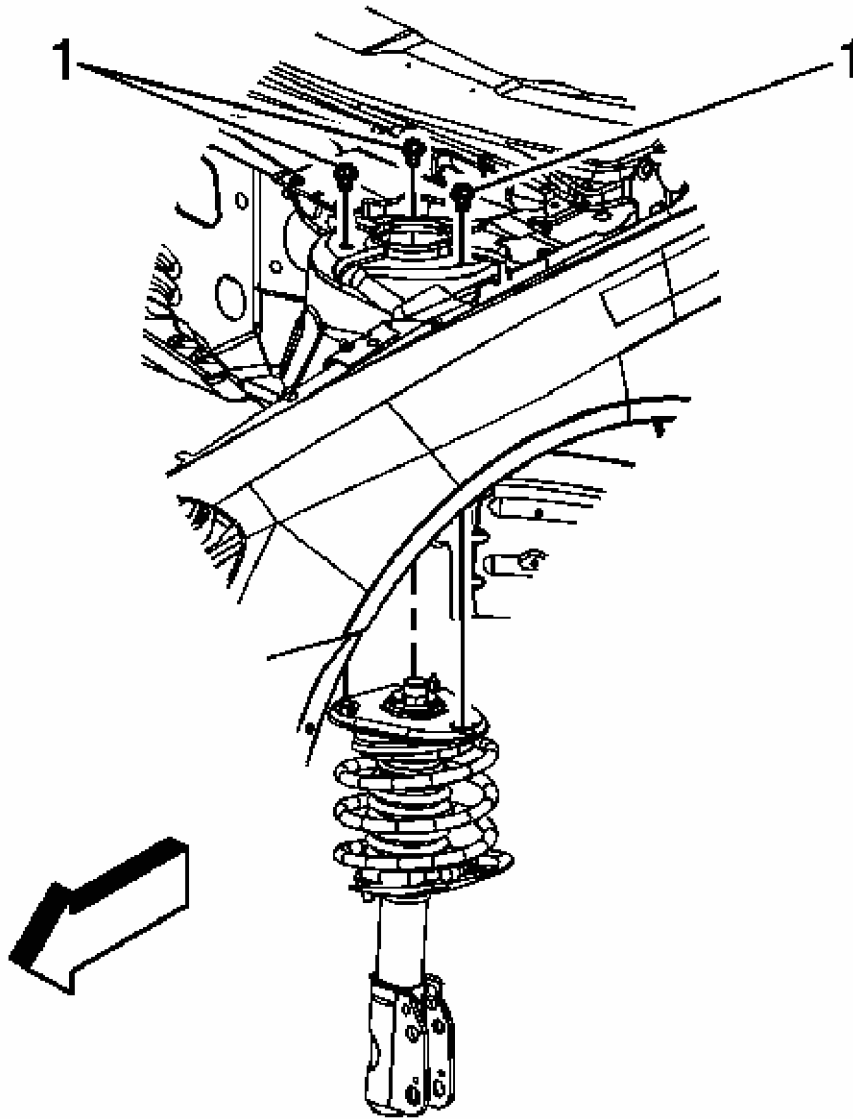


Fig. 146: Locating Strut Tower Bolts
Courtesy of GENERAL MOTORS CORP.

119. Install the left and right side strut tower bolts (1). (Left side shown, right side similar).

Tighten: Tighten the bolts to 40 N.m (30 lb ft).

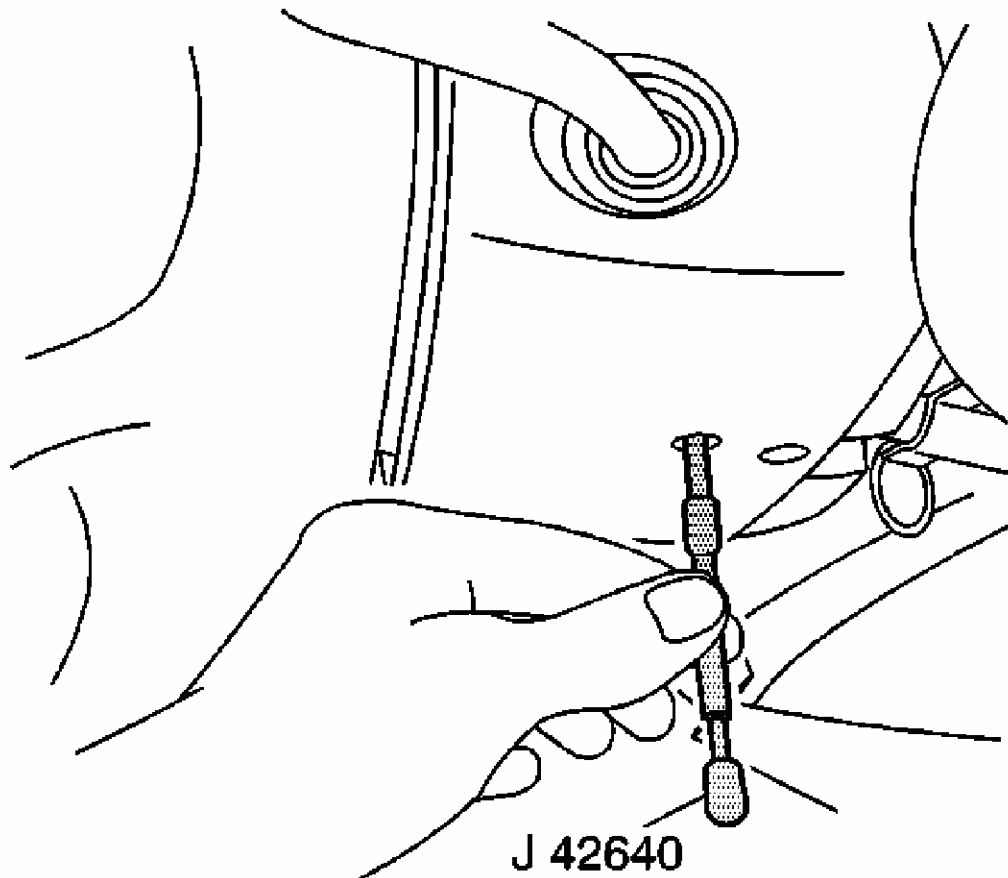


Fig. 147: Identifying J 42640
Courtesy of GENERAL MOTORS CORP.

120. Remove the **J 42640** from the steering column. See **Special Tools** .

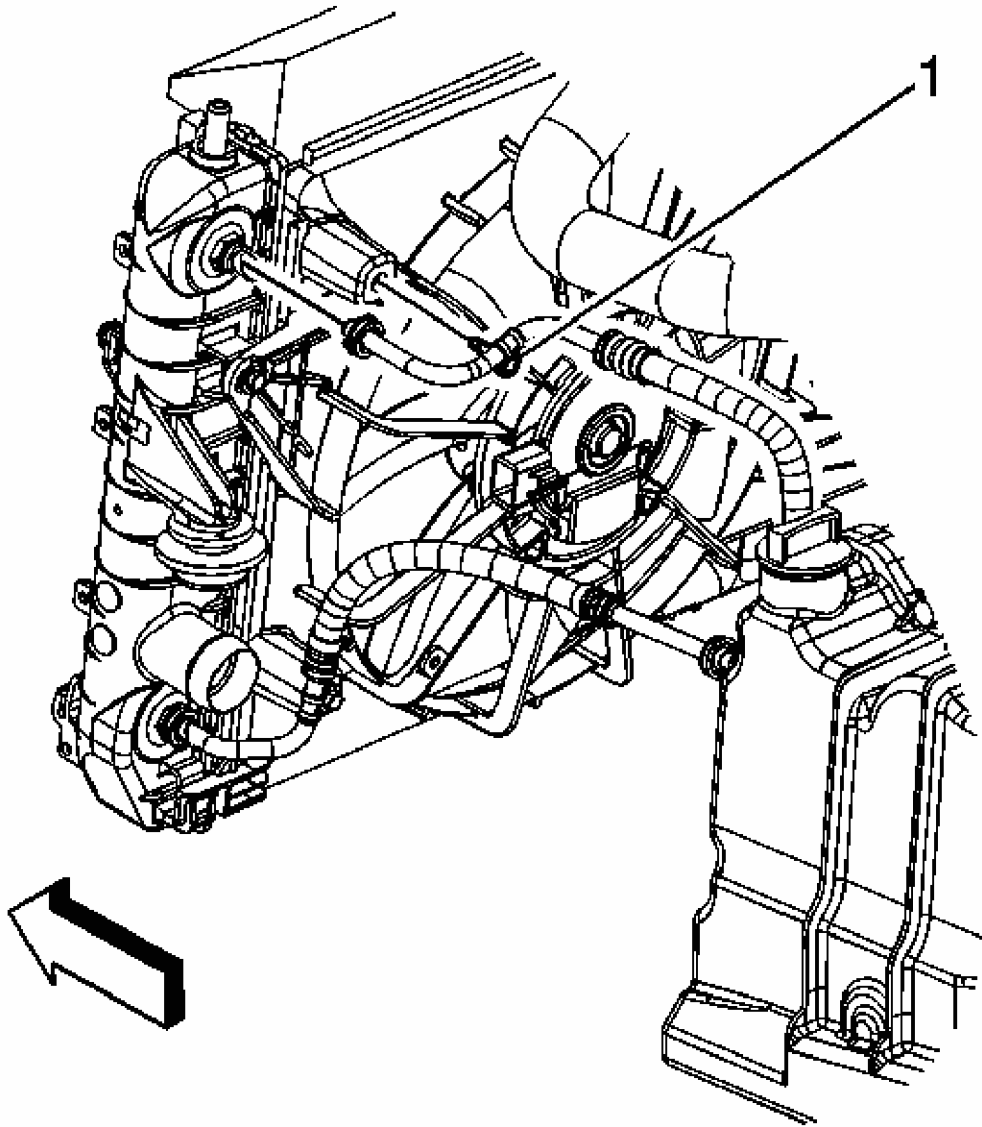


Fig. 148: Identifying Upper Transaxle Oil Cooler Pipe Bolt & Bolt
Courtesy of GENERAL MOTORS CORP.

- |21. Connect the transaxle oil cooler pipes to the radiator.
- |22. Slide the plastic caps onto the transaxle oil cooler pipe quick connect fittings.
- |23. Tighten the upper transaxle oil cooler pipe bolt (1) to the fan shroud.

Tighten: Tighten the bolt to 6 N.m (53 lb in).

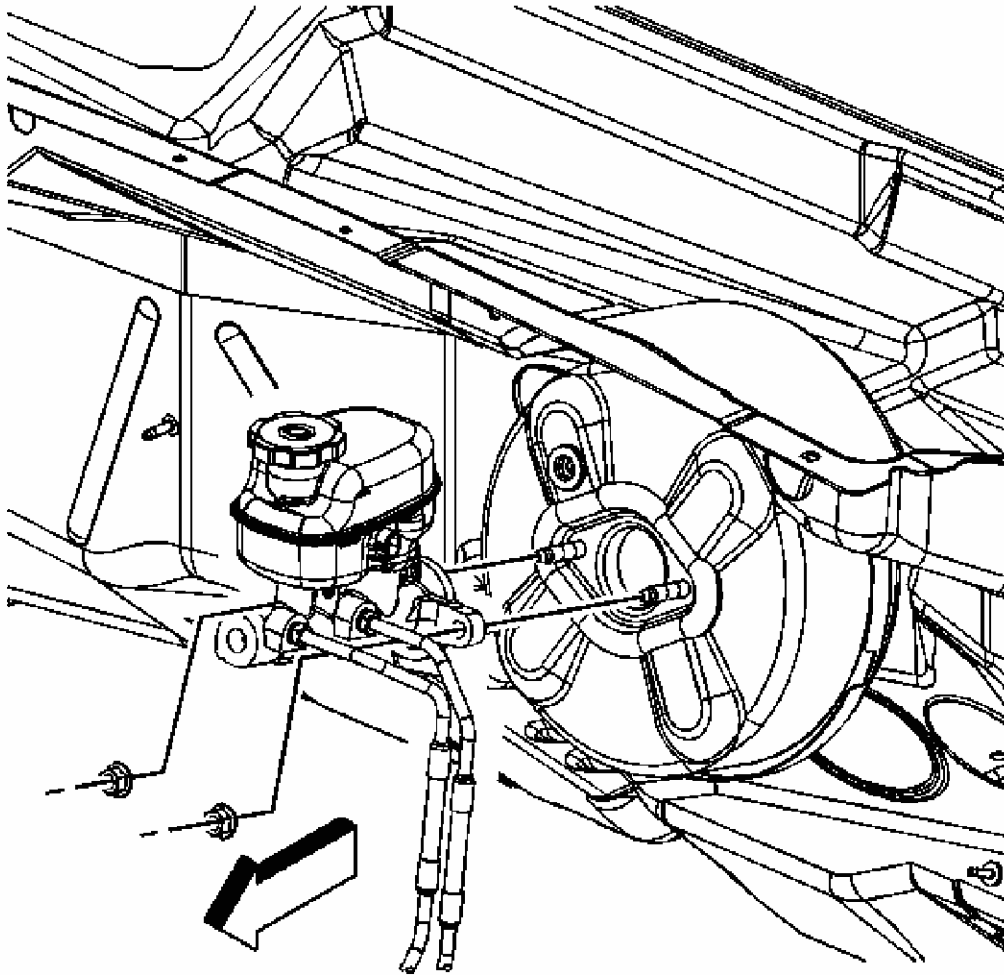


Fig. 149: View Of Master Cylinder & Brake Booster
Courtesy of GENERAL MOTORS CORP.

- |24. Unsecure the master cylinder from the engine and position the master cylinder the brake booster.
- |25. Install the master cylinder nuts.

Tighten: Tighten the nuts to 30 N.m (22 lb ft).

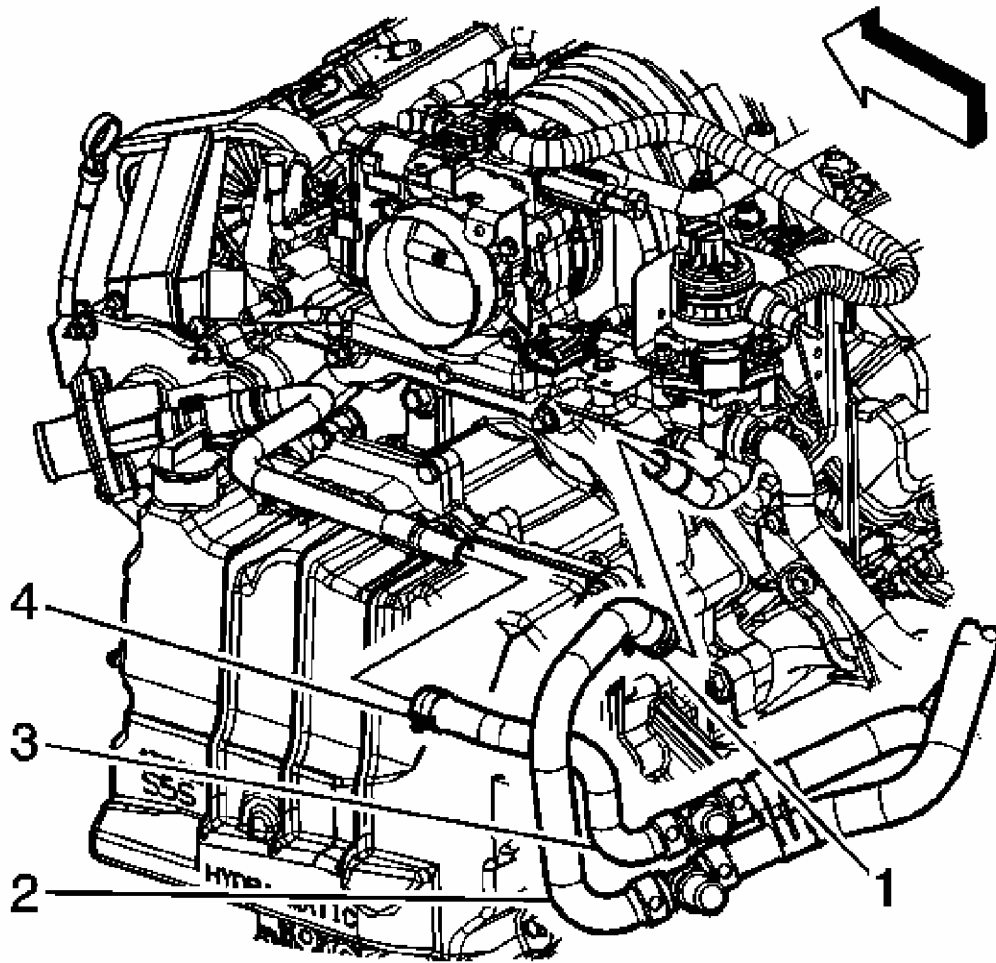


Fig. 150: Identifying Heater Inlet & Outlet Hoses
Courtesy of GENERAL MOTORS CORP.

- |26. Install the heater inlet (2) and outlet (3) hoses to the heater pipes.
- |27. Position the heater inlet (1) and outlet (2) hose clamps at the heater pipes.

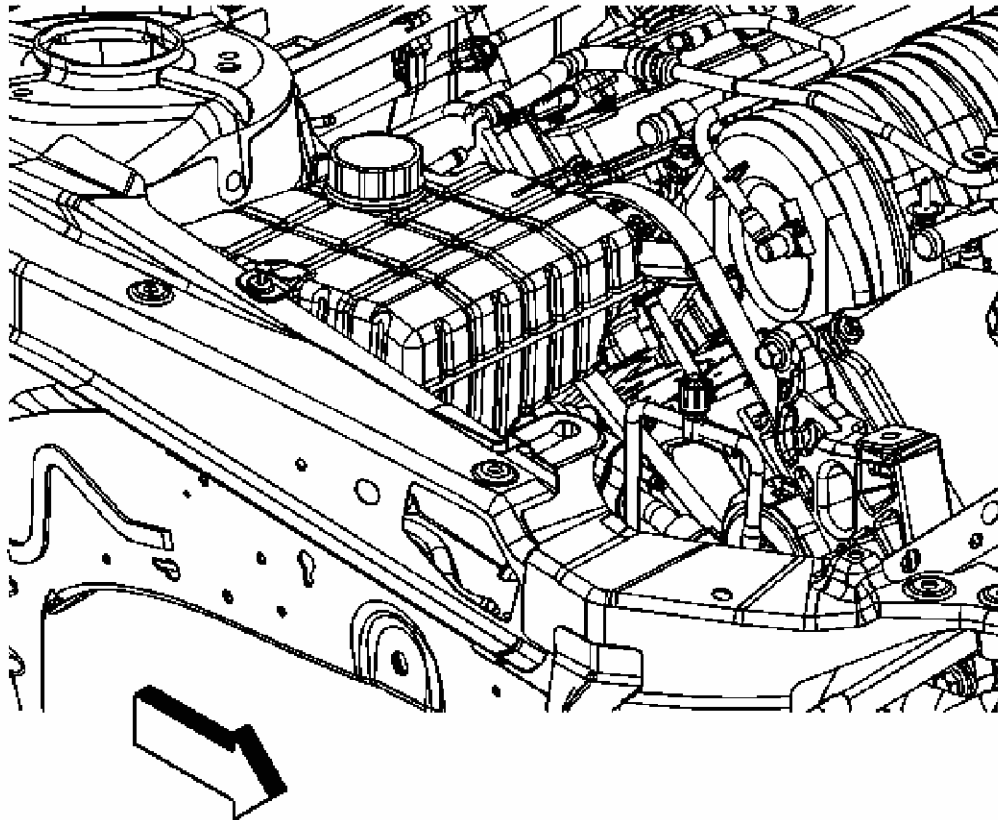


Fig. 151: Identifying Surge Tank Inlet Hose/Pipe
Courtesy of GENERAL MOTORS CORP.

- |28. Install the surge tank inlet hose to the surge tank.
- |29. Position the radiator surge tank inlet hose clamp at the surge tank.

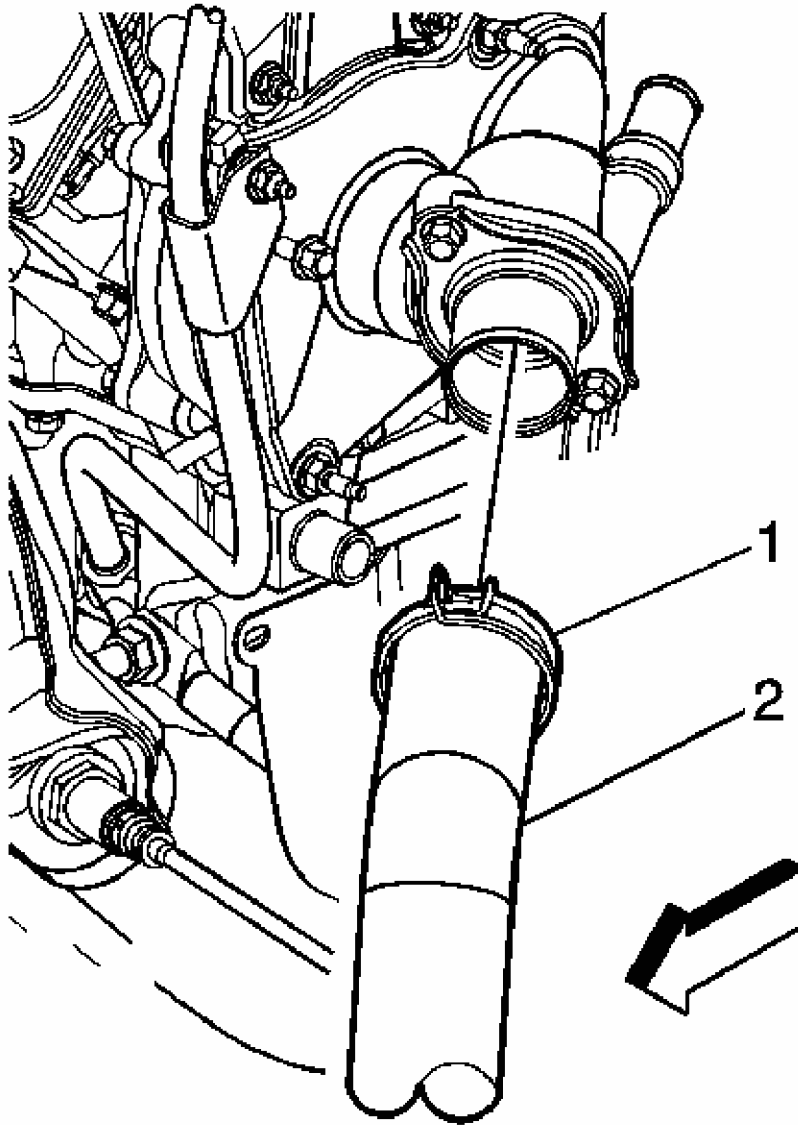


Fig. 152: View Of Radiator Outlet Hose At Thermostat Housing
Courtesy of GENERAL MOTORS CORP.

- l30. Install the radiator outlet hose (2) to the thermostat housing.
- l31. Using the **J 38185** position the radiator outlet hose clamp (1).

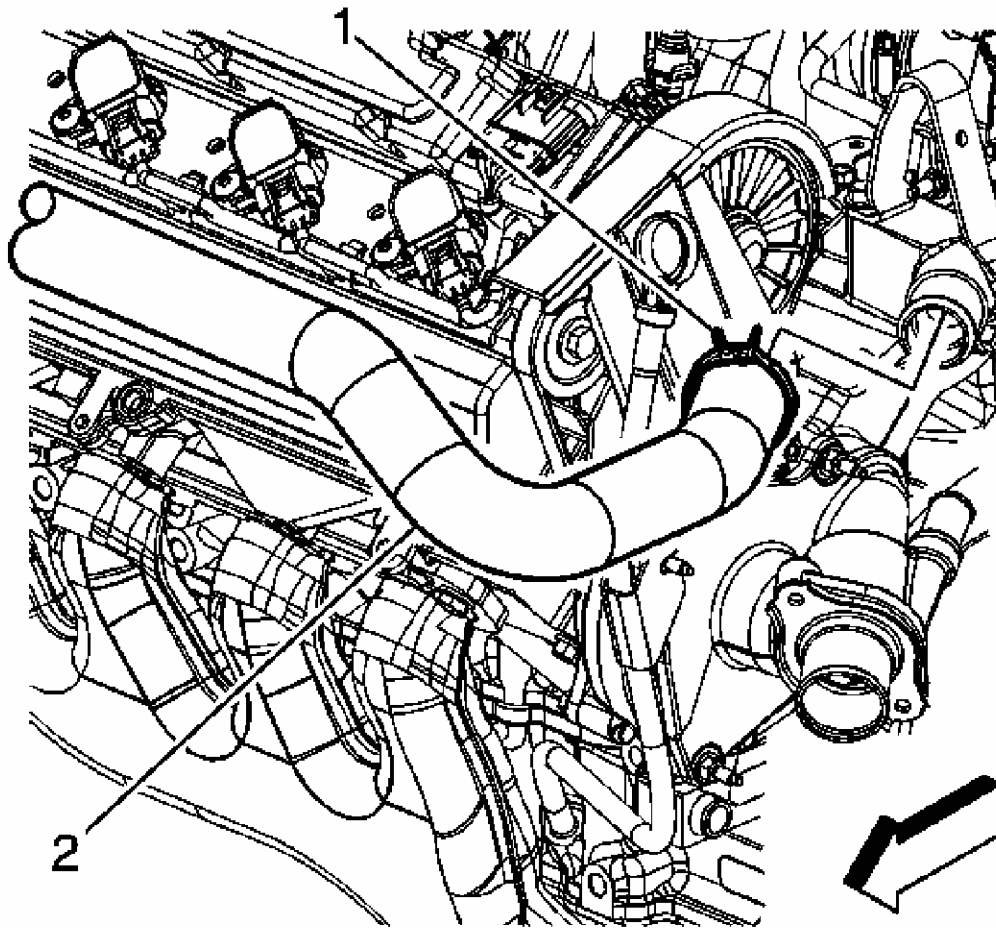


Fig. 153: View Of Radiator Inlet Hose & Clamp
Courtesy of GENERAL MOTORS CORP.

- l32. Install the radiator inlet hose (2) to the water pump housing.
- l33. Using the **J 37097-A** position the radiator inlet hose clamp (1). See **Special Tools** .

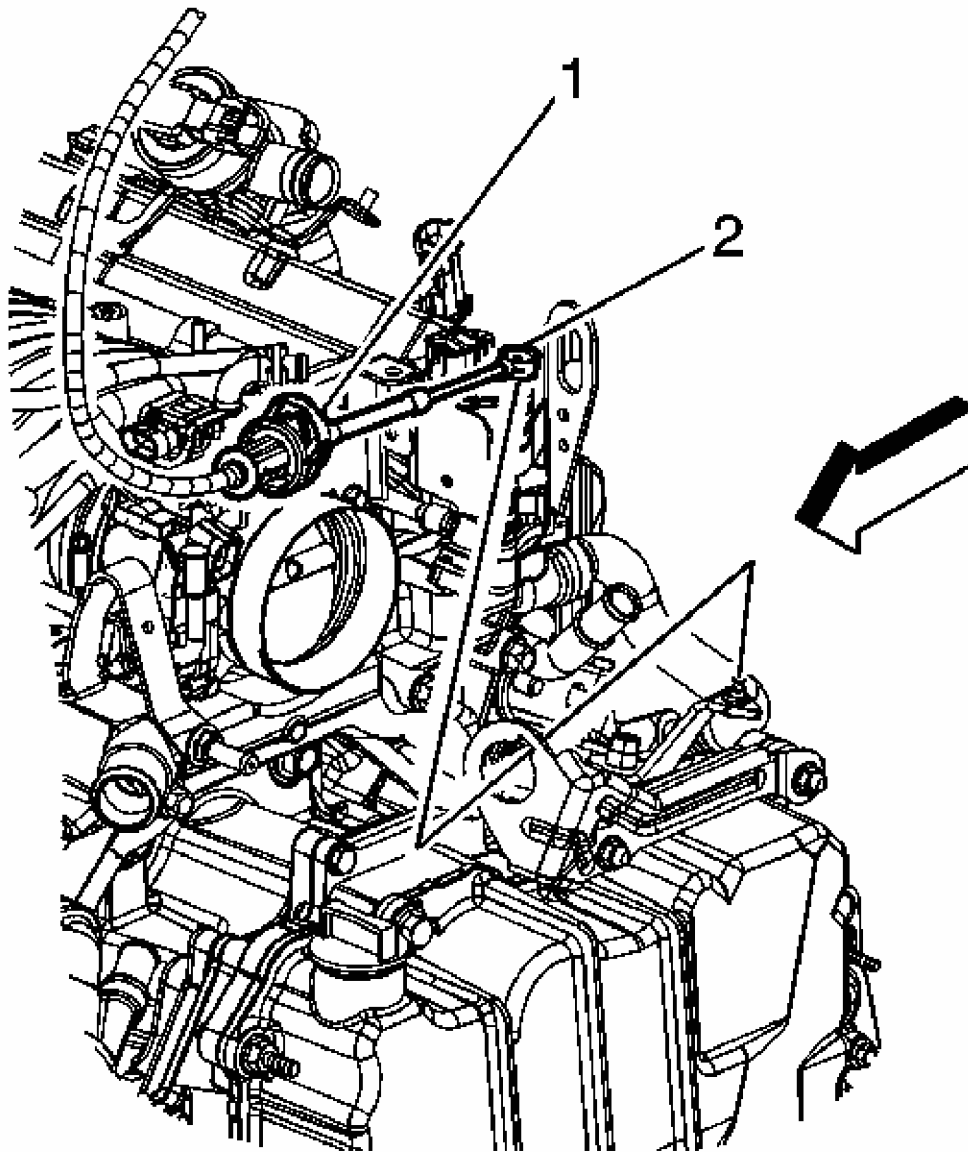


Fig. 154: View Of Transaxle Shift Cable
Courtesy of GENERAL MOTORS CORP.

- l34. Install the transaxle shift cable to the bracket.
- l35. Connect the transaxle shift cable end (2) to the range selector lever (1).

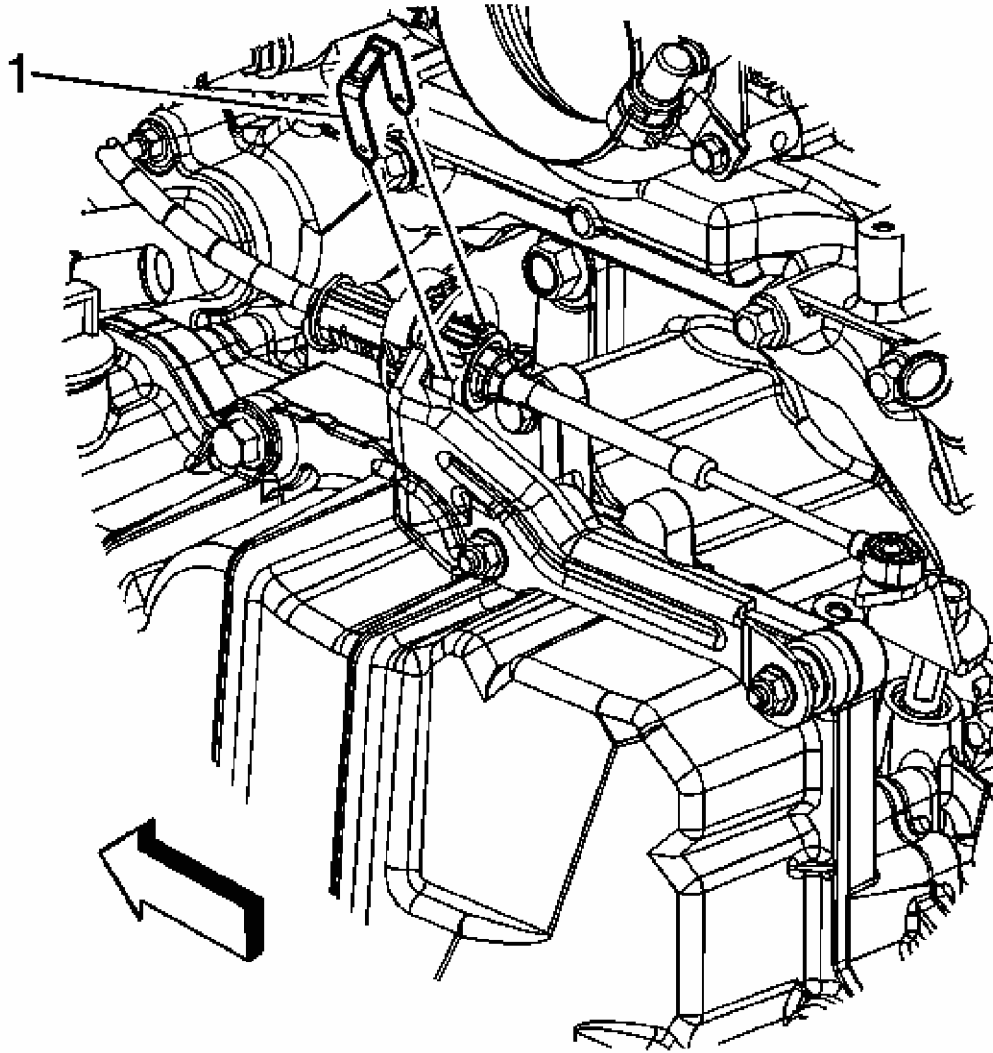


Fig. 155: Identifying Transaxle Shift Cable Retainer
Courtesy of GENERAL MOTORS CORP.

136. Install the transaxle shift cable retainer (1).

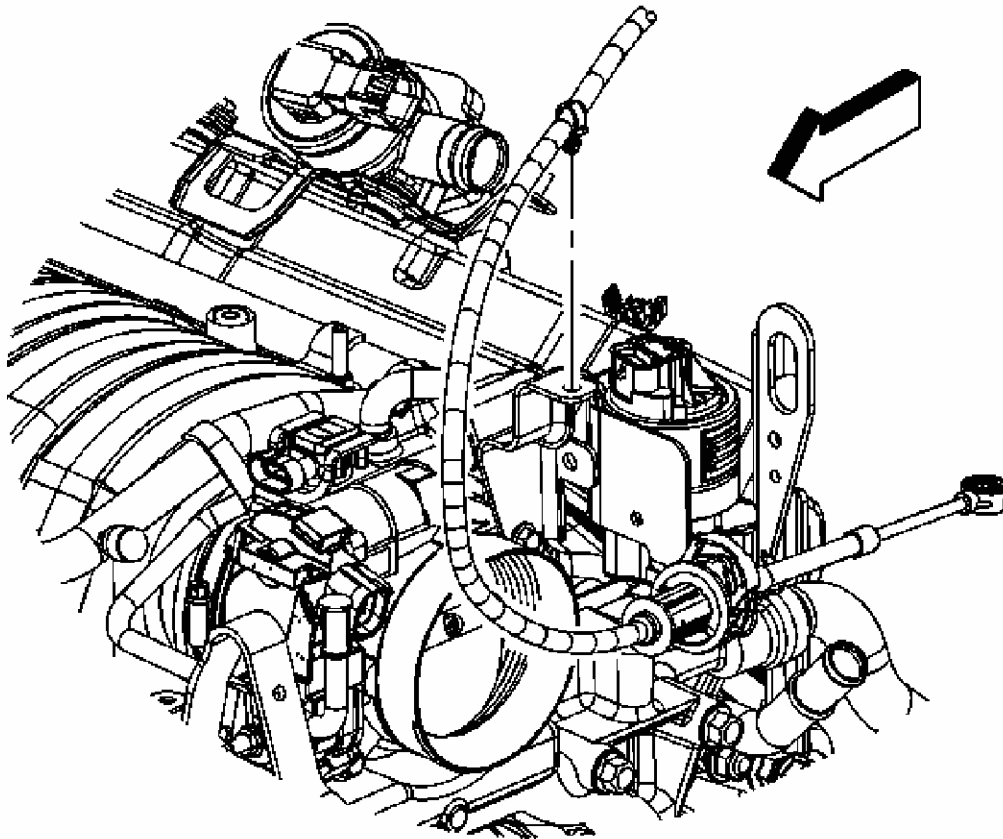


Fig. 156: Identifying Transaxle Shift Cable
Courtesy of GENERAL MOTORS CORP.

137. Install the transaxle shift cable clip to the shift cable bracket.

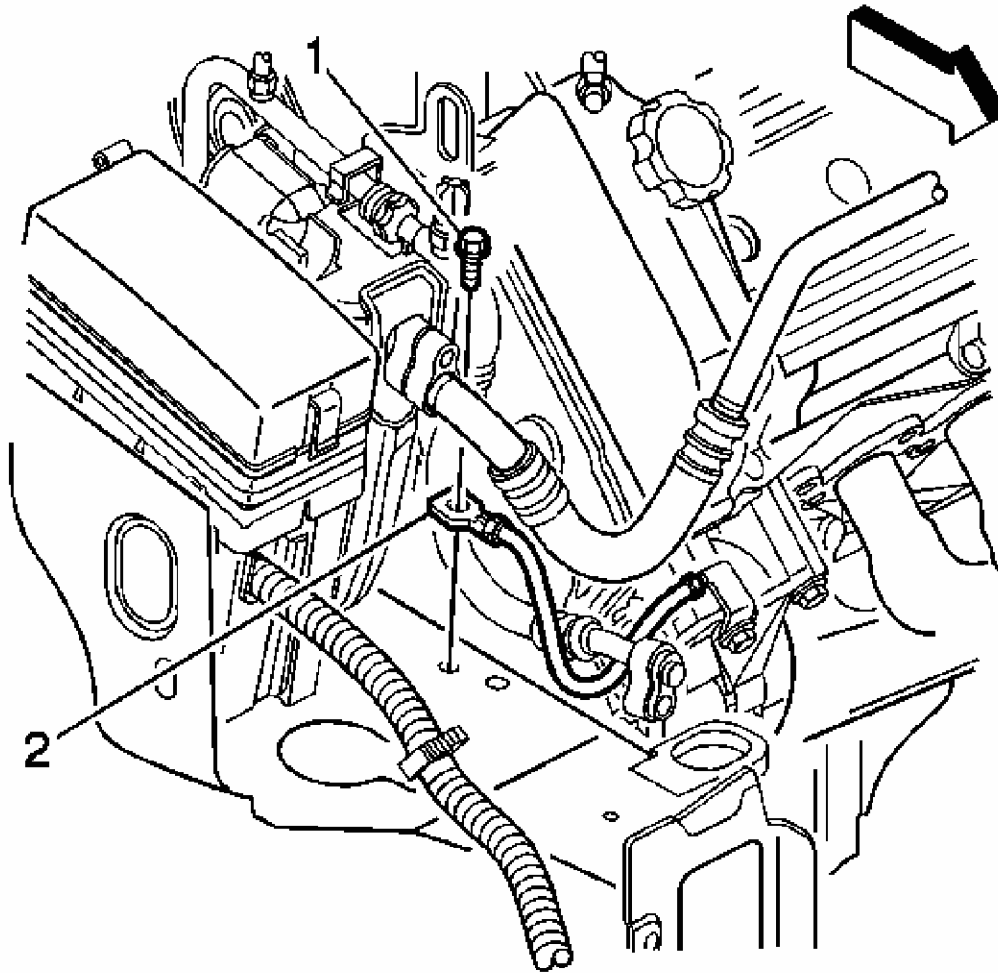


Fig. 157: Identifying Engine Ground Cable
Courtesy of GENERAL MOTORS CORP.

- l38. Position the ground strap to the frame rail.
- l39. Install the engine ground strap bolt (1) to the right side frame rail.

Tighten: Tighten the bolt to 25 N.m (18 lb ft).

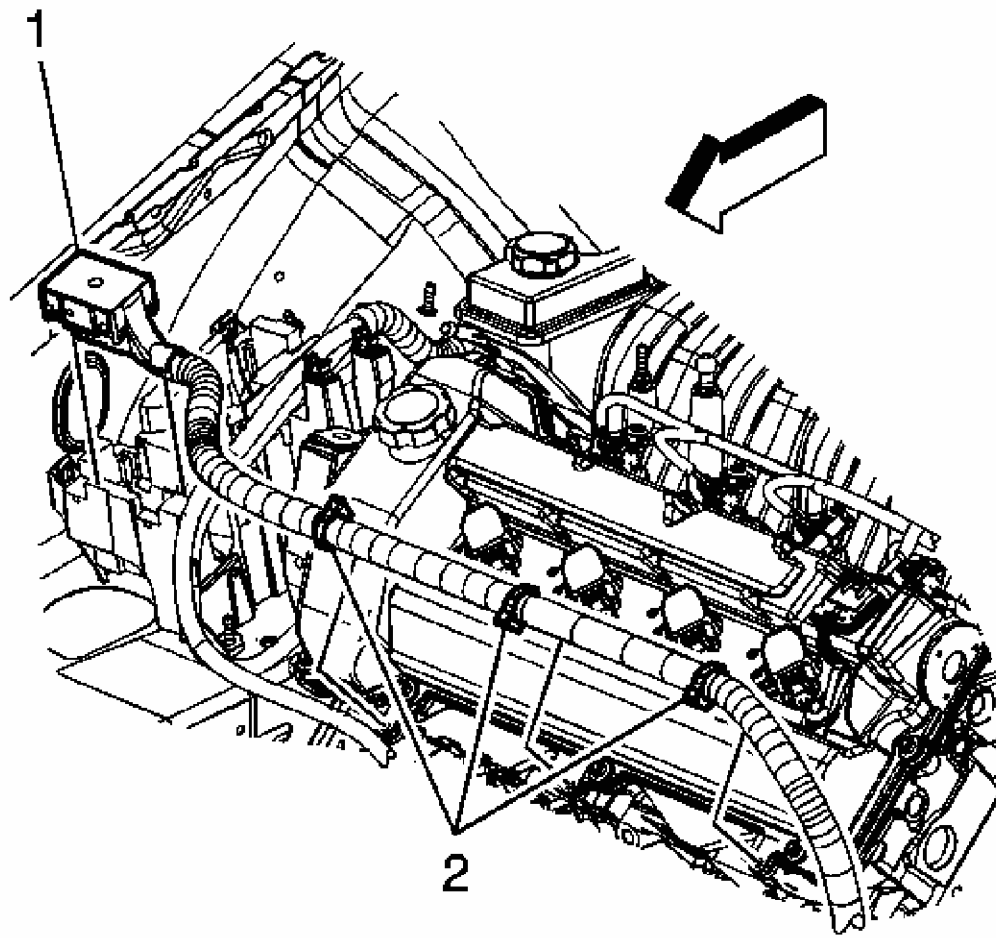


Fig. 158: View Of Engine Harness & Clips
Courtesy of GENERAL MOTORS CORP.

140. Install the engine harness (1) to the BEC.

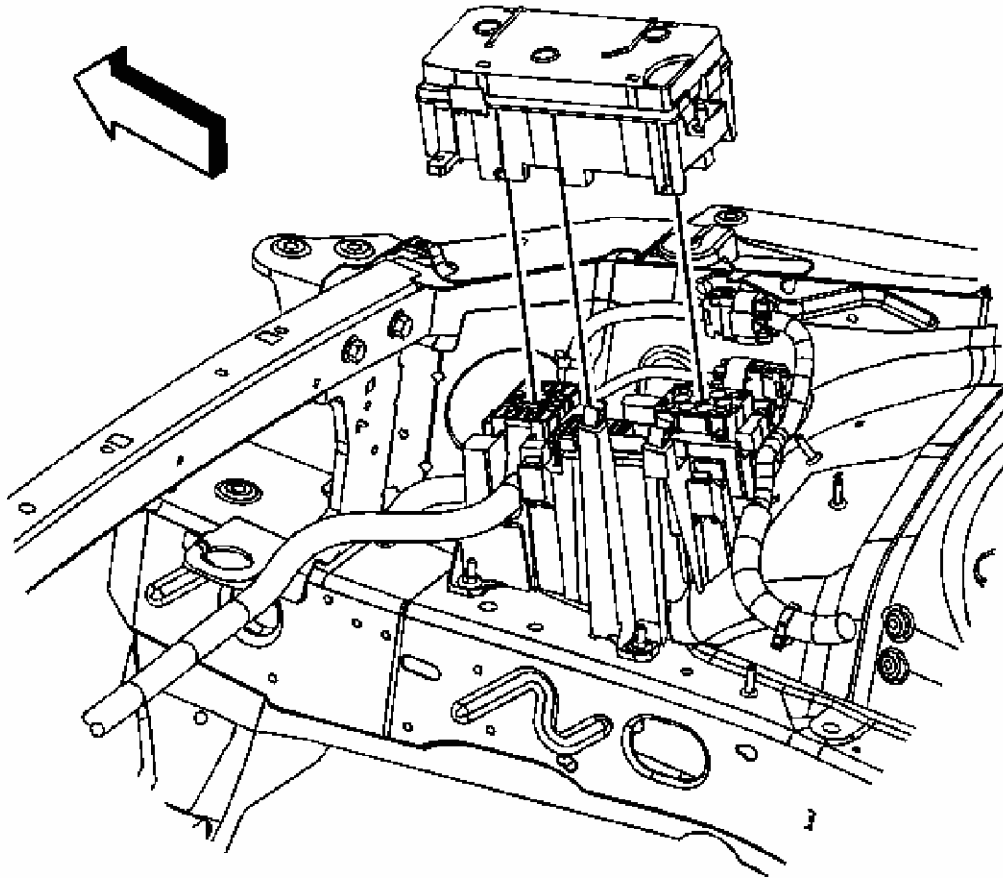


Fig. 159: View Of Junction Block
Courtesy of GENERAL MOTORS CORP.

- |41. Install the junction block.
- |42. Install the junction block bolts.

Tighten: Tighten the bolts to 6.5 N.m (58 lb in).

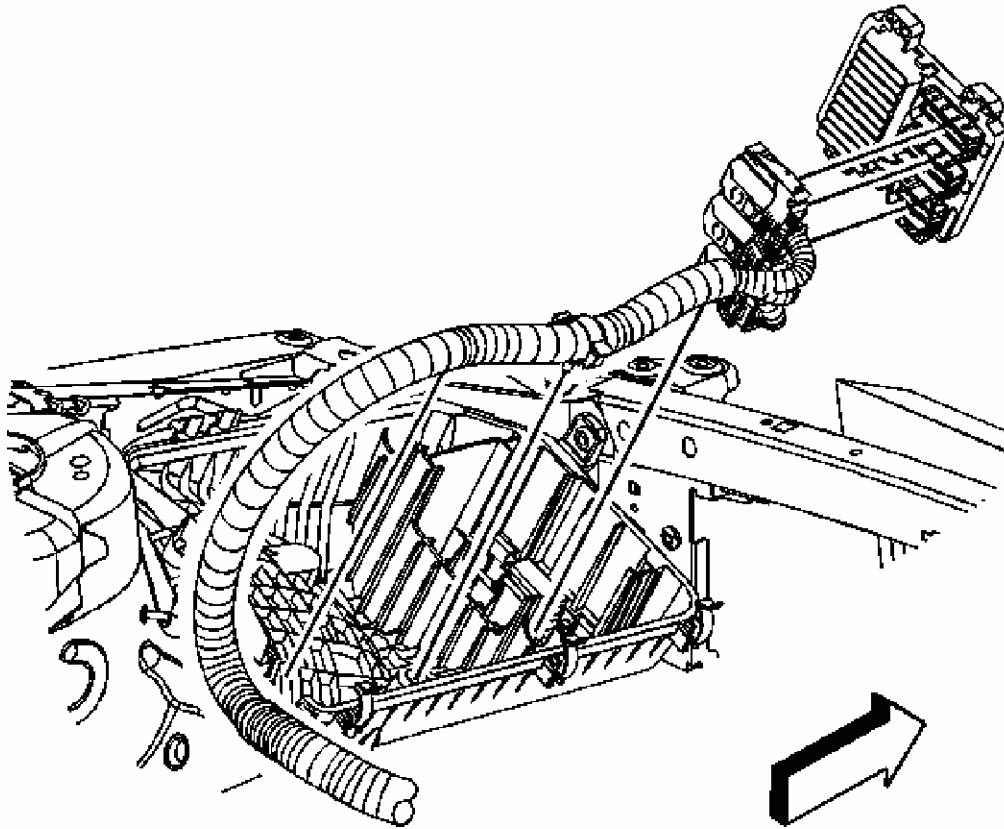


Fig. 160: Identifying Air Cleaner Lower Housing
Courtesy of GENERAL MOTORS CORP.

- |43. Connect the engine harness electrical connectors to the ECM.
- |44. Engage the lever locks.

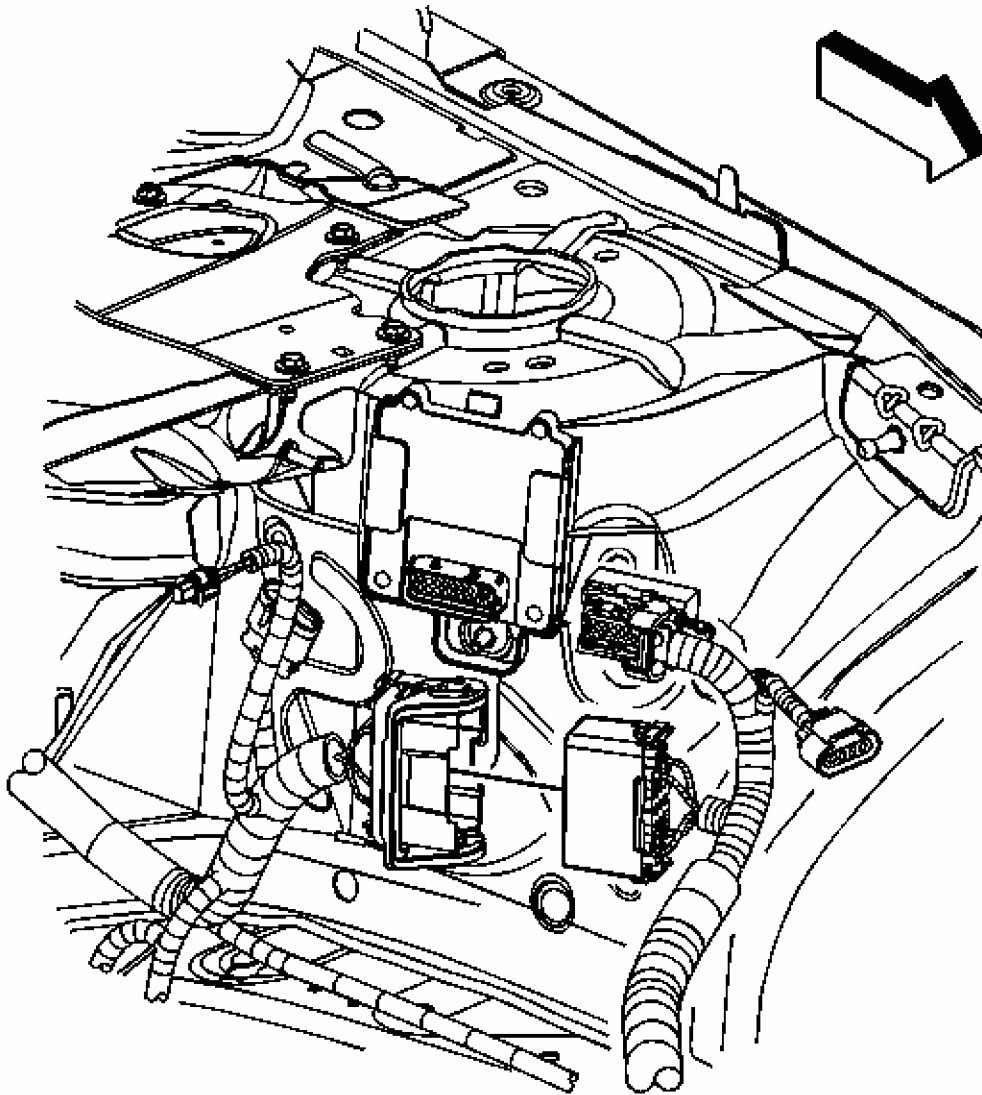


Fig. 161: Identifying Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

- |45. Connect the engine harness electrical connector to the body harness electrical connector.
- |46. Engage the lever lock.

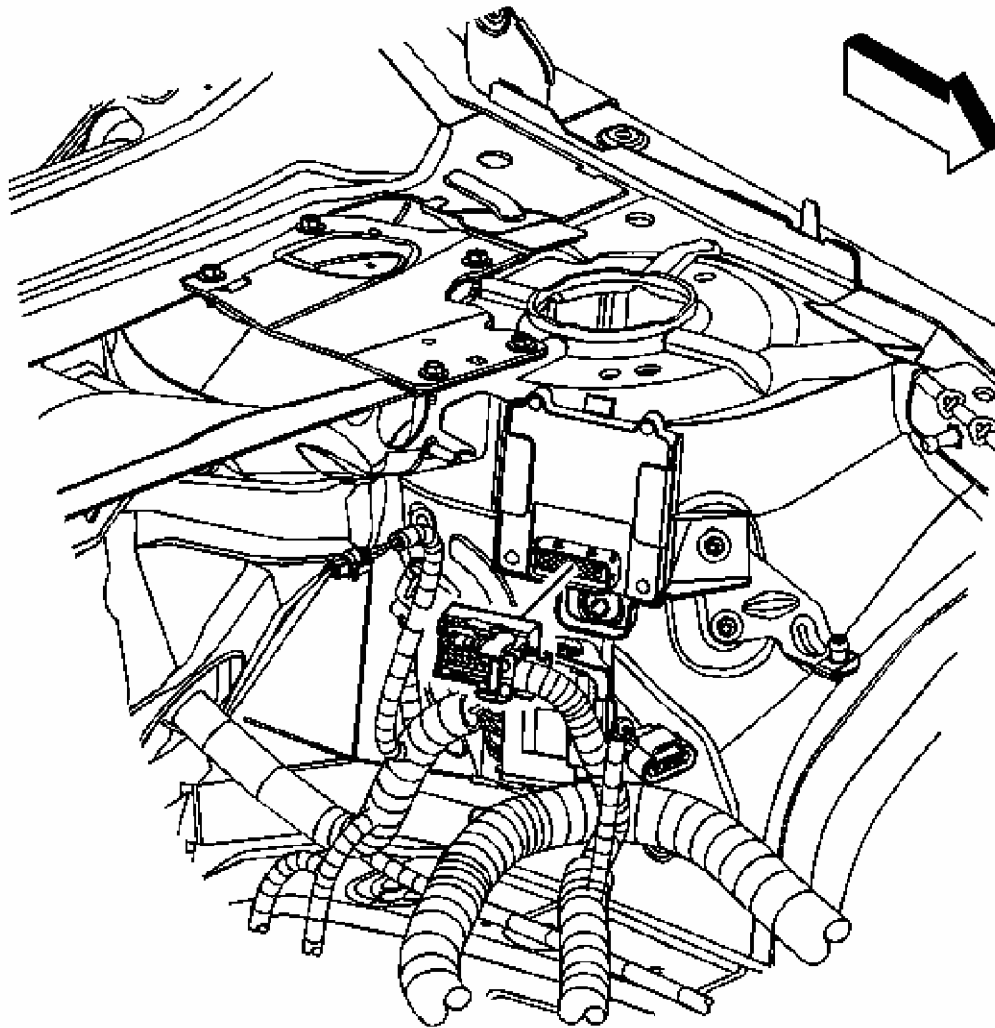


Fig. 162: View Of Engine Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

- |47. Connect the engine harness electrical connector to the TCM.
- |48. Engage the lever lock.

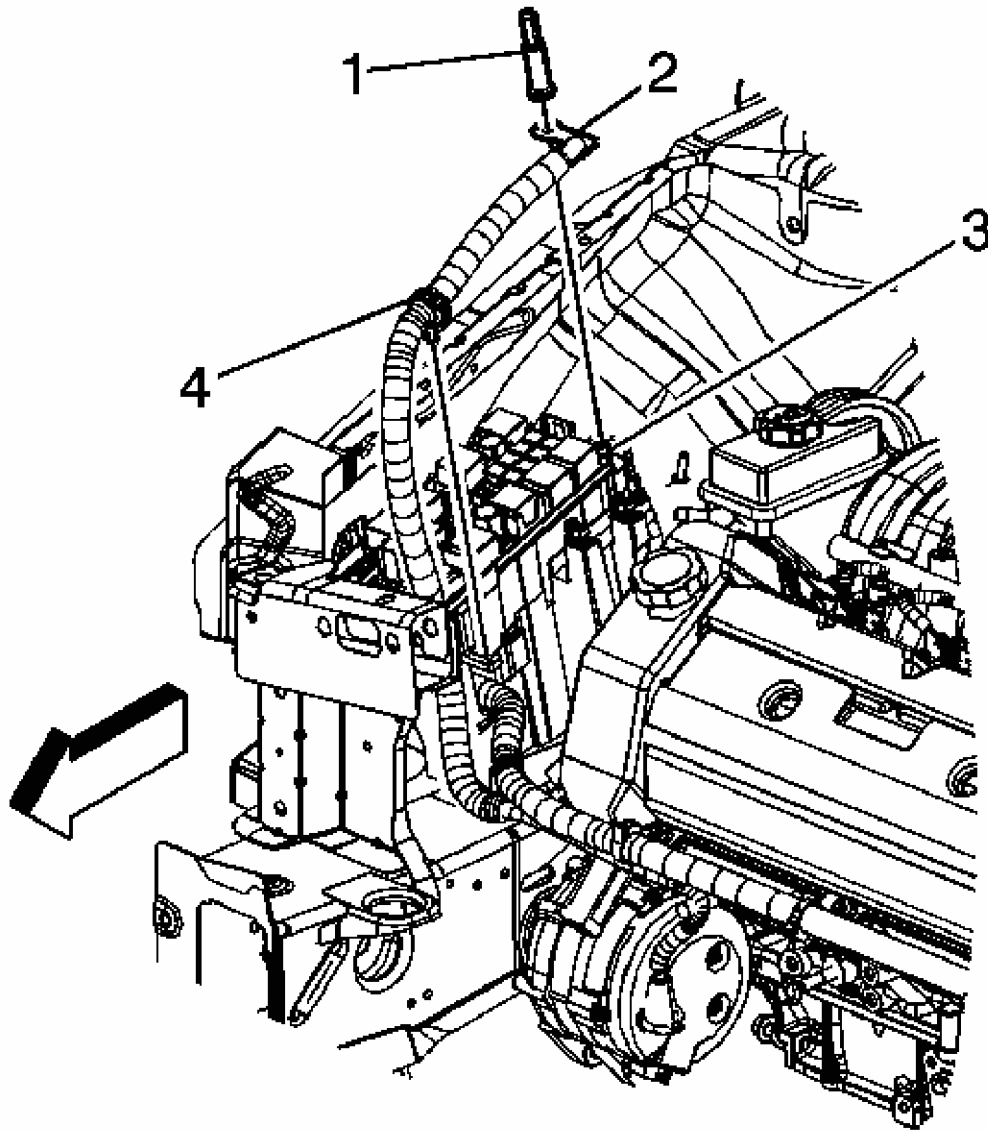


Fig. 163: Identifying Starter Solenoid Cable To Bussed Electrical Center (BEC)
Courtesy of GENERAL MOTORS CORP.

- l49. Install the starter cable to the BEC terminal.
- l50. Install the starter cable clip (4) to the BEC.
- l51. Install the nut (1) securing the starter cable to the BEC.

Tighten: Tighten the nut to 15 N.m (11 lb ft).

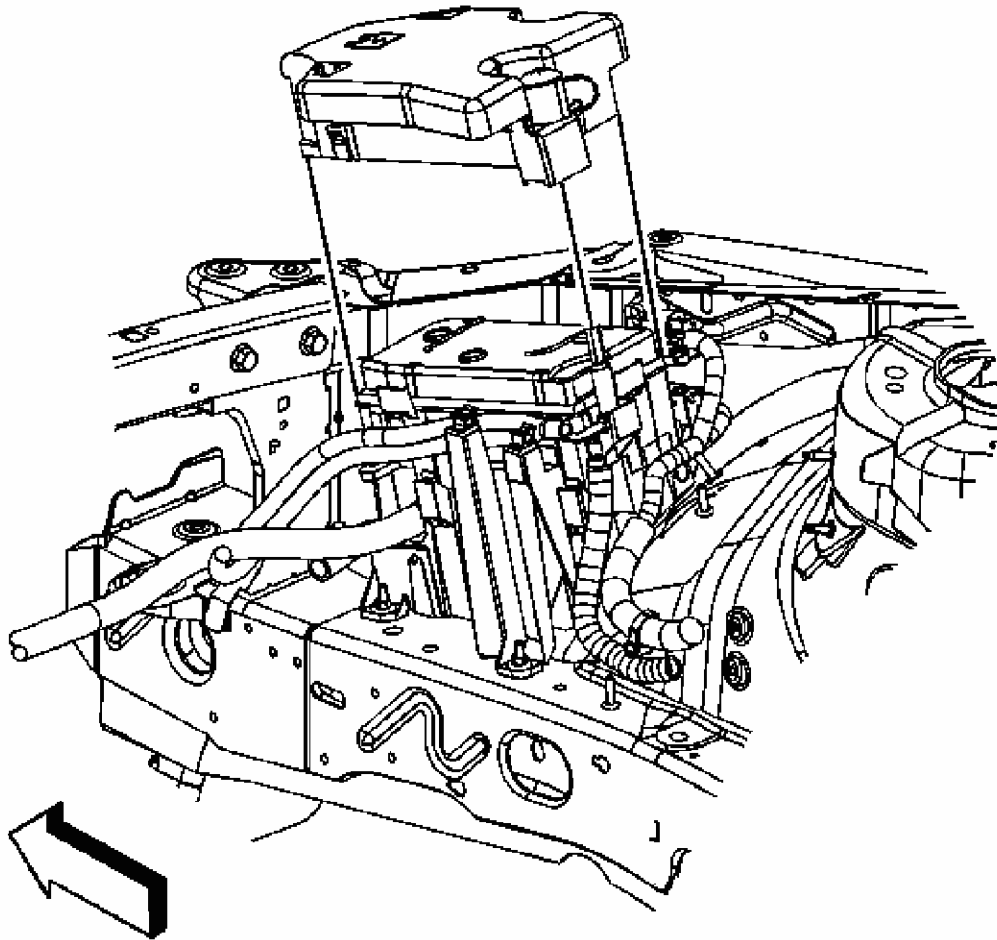


Fig. 164: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

- 152. Install the junction block cover.
- 153. Install the air cleaner. Refer to **Air Cleaner Assembly Replacement** .
- 154. Install the front compartment sight shield. Refer to **Front Compartment Sight Shields Replacement** .

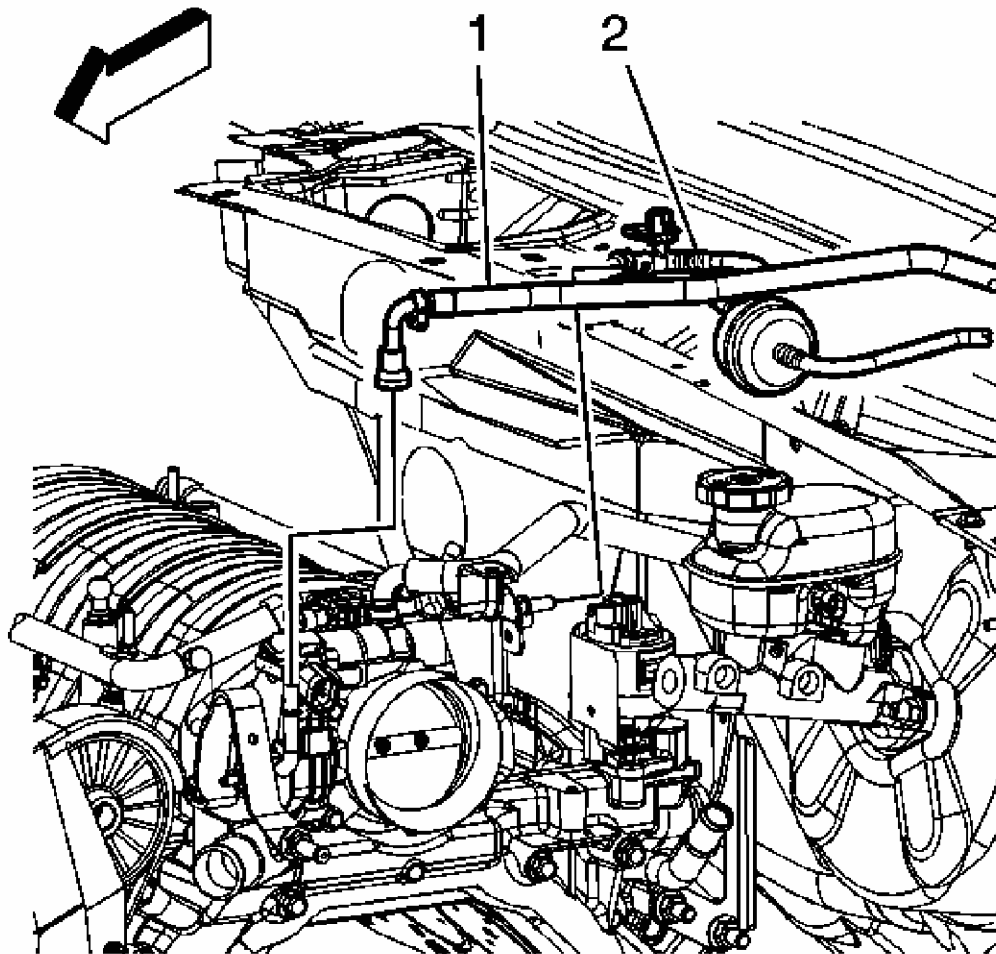


Fig. 165: Identifying Fuel Feed Pipe & EVAP Line Quick Connect Fitting
Courtesy of GENERAL MOTORS CORP.

155. Connect the fuel feed and EVAP line quick-connect fittings (1, 2). Refer to **Metal Collar Quick Connect Fitting Service** and **Plastic Collar Quick Connect Fitting Service** .

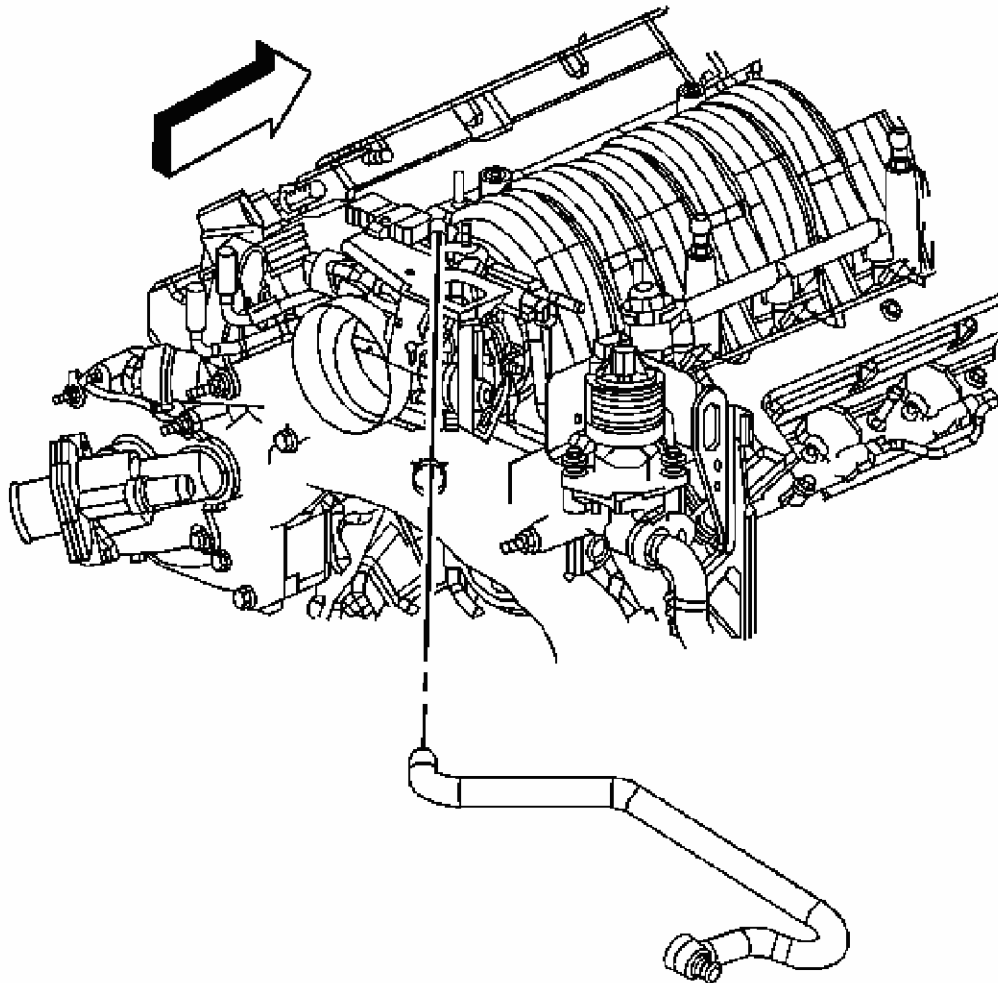


Fig. 166: View Of Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

- 156. Connect the brake booster vacuum hose to the vacuum connection.
- 157. Position the brake booster vacuum hose clamp at the engine port.
- 158. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
- 159. Fill the engine with oil. Refer to **Engine Oil and Oil Filter Replacement**.
- 160. Fill the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** or **Cooling System Draining and Filling (Vac-N-Fill)** .
- 161. Bleed the brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** or **Hydraulic Brake System Bleeding (Pressure)** .

- l62. Recharge the A/C refrigerant system. Refer to **Refrigerant Recovery and Recharging** .
- l63. Bleed the power steering system. Refer to **Power Steering System Bleeding** .
- l64. Check the wheel alignment. Refer to **Wheel Alignment Measurement** .
- l65. Pre-lube the engine. Refer to **Engine Prelubing** .
- l66. Install the fuel injector sight shield. Refer to **Fuel Injector Sight Shield Replacement** .
- l67. With the ignition OFF or disconnected, crank the engine several times. Listen for any unusual noises or evidence that any parts are binding.
- l68. Start the engine and listen for abnormal conditions.
- l69. Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
- l70. Run the engine at approximately 1000 RPM until the engine reaches normal operating temperature.
- l71. While the engine continues to idle raise and support the vehicle.
- l72. Inspect for oil, coolant and exhaust leaks while the engine is idling.
- l73. Lower the vehicle.
- l74. Perform the crankshaft position (CKP) system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .
- l75. Perform a final inspection for the proper engine oil and coolant levels.
- l76. Road test the vehicle.

ENGINE OIL AND OIL FILTER REPLACEMENT

REMOVAL PROCEDURE

- 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
- 2. Position the oil drain pan under the engine oil drain plug.

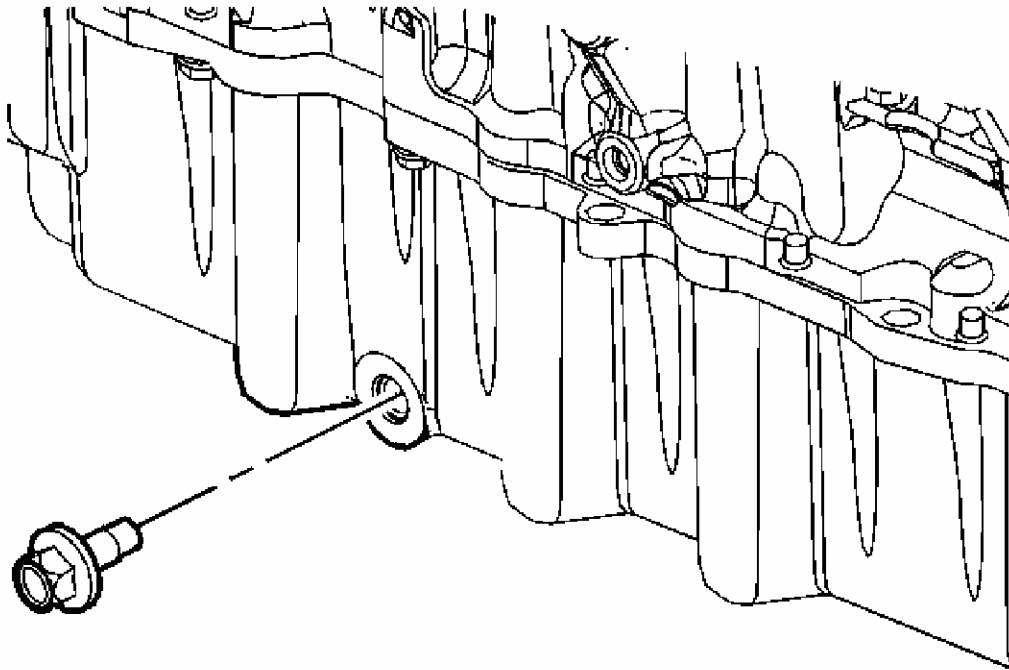


Fig. 167: View Of Engine Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine oil drain plug.
4. Clean and inspect the engine oil drain plug, replace if necessary.
5. Clean and inspect the engine oil drain plug sealing surface on the oil pan, repair or replace oil pan if necessary.

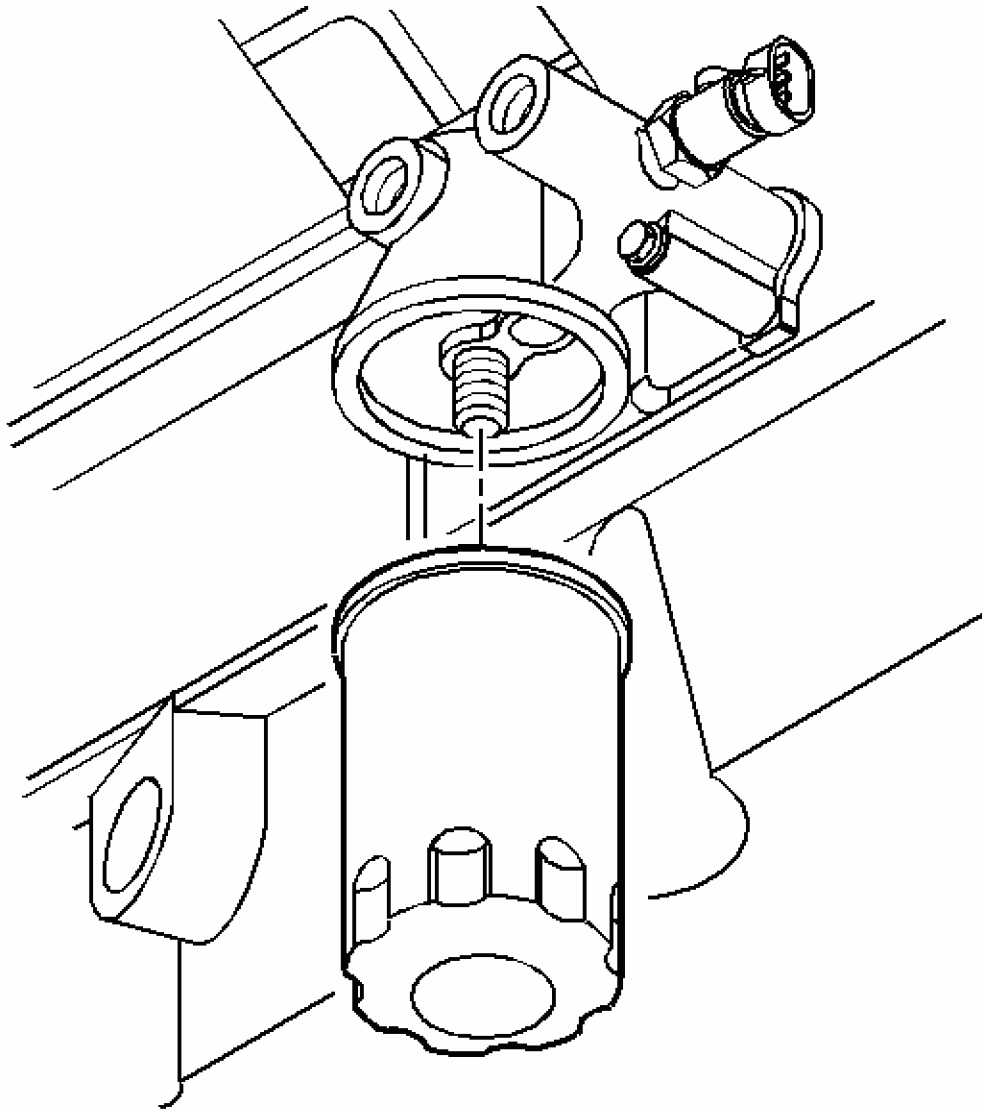


Fig. 168: Locating Oil Filter Adapter & Filter
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil filter.
7. Clean and inspect the oil filter sealing area on the oil filter adapter, repair or replace if necessary.

INSTALLATION PROCEDURE

1. Fill the oil filter with oil.

2. Lightly oil the replacement oil filter gasket with clean oil.

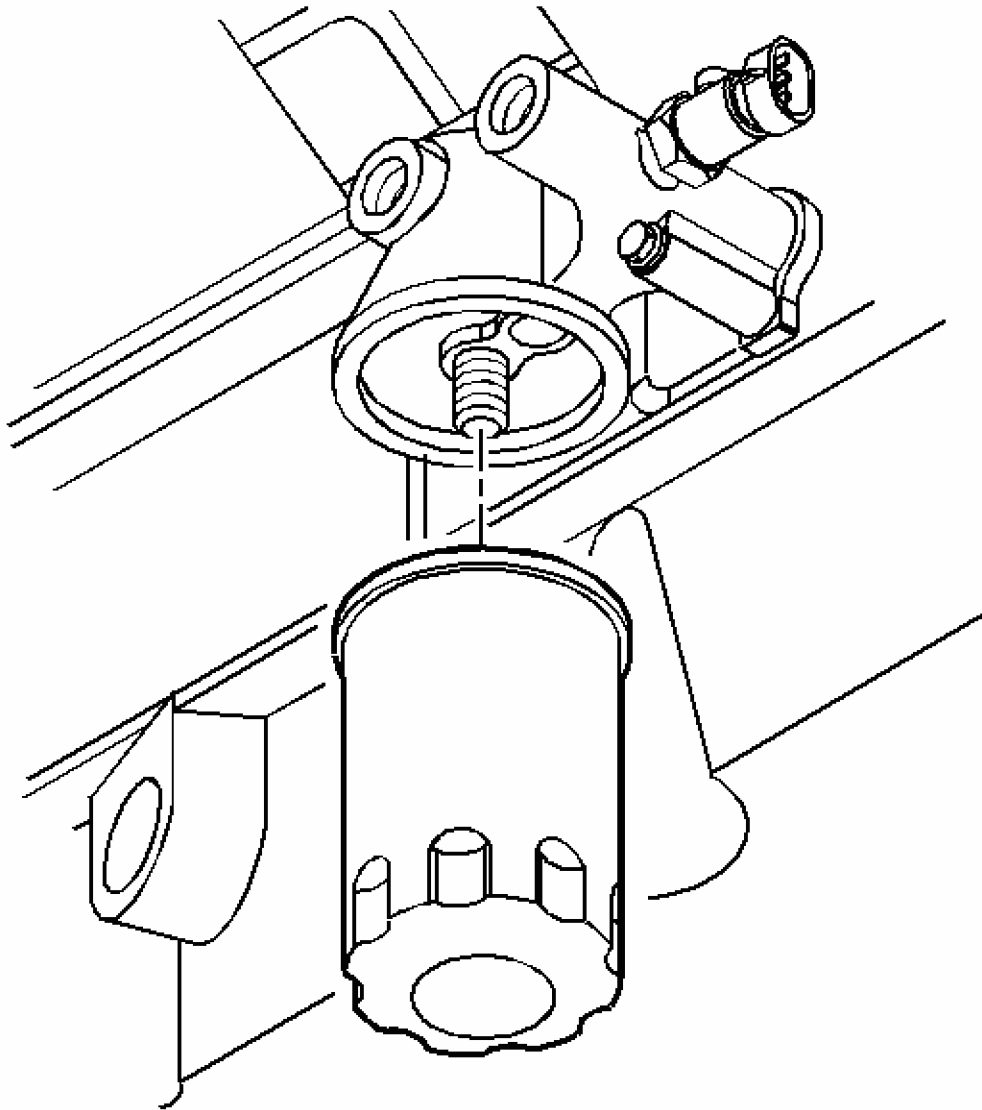


Fig. 169: Locating Oil Filter Adapter & Filter
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to FASTENER NOTICE .

3. Install the new oil filter.

Tighten: Tighten the new oil filter to 3/4 to 1 full turn, after the oil filter gasket contacts

the oil filter mounting surface.

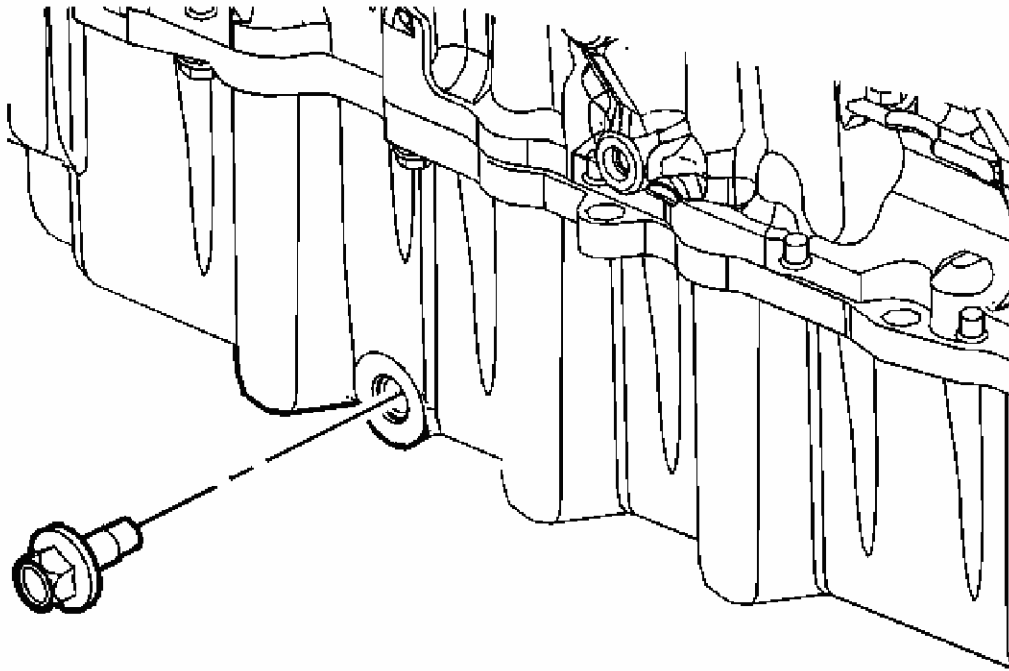


Fig. 170: View Of Engine Oil Drain Plug
Courtesy of GENERAL MOTORS CORP.

4. Install the engine oil drain plug.

Tighten: Tighten the engine oil drain plug to 20 N.m (15 lb ft).

5. Lower the vehicle.
6. Fill the engine with new engine oil. Refer to **Approximate Fluid Capacities** and **Fluid and Lubricant Recommendations** .
7. Inspect for oil leaks after engine start up.

DRIVE BELT REMOVAL

REMOVAL PROCEDURE

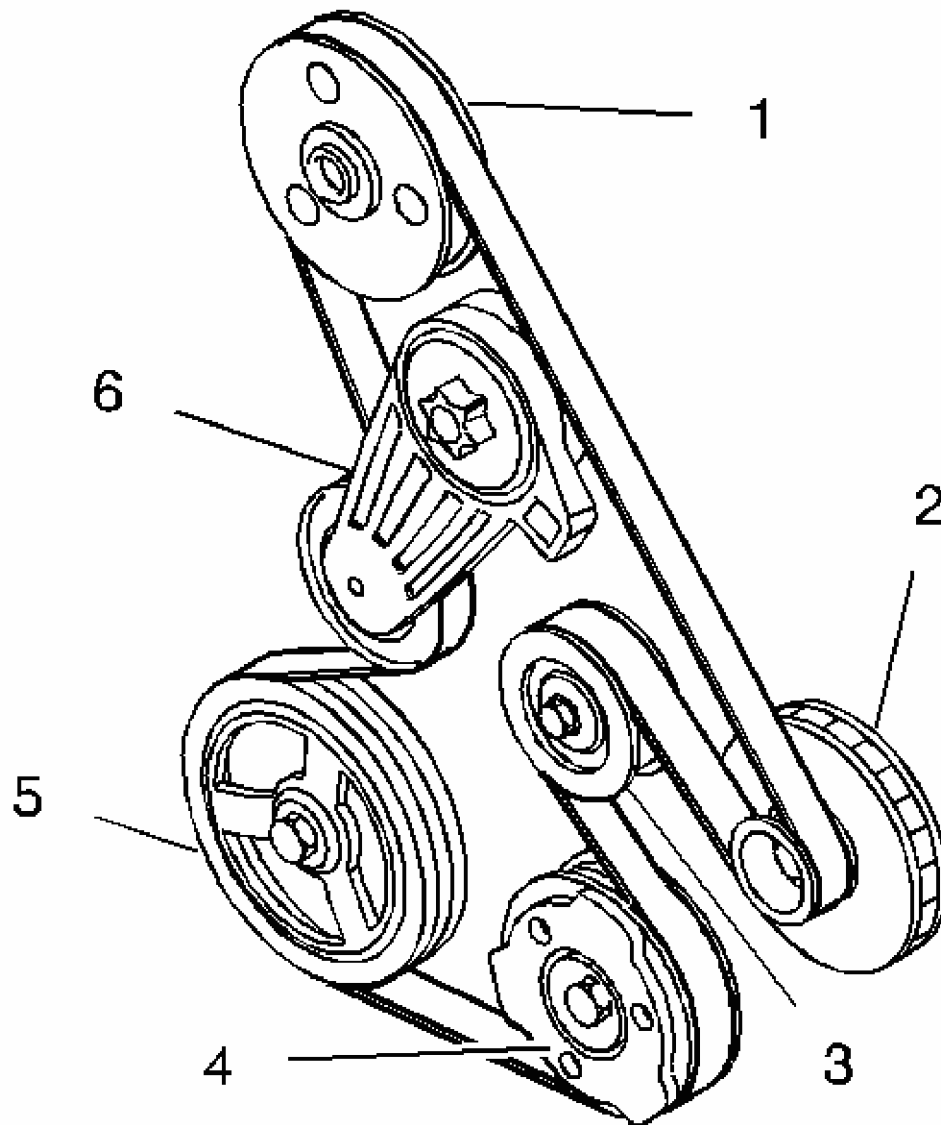


Fig. 171: Identifying Power Steering Pulleys, Drive Belt & Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Insert a 1/2-inch drive ratchet in the drive belt tensioner (6).
2. Rotate the drive belt tensioner clockwise in order to release the belt tension.
3. Remove the drive belt from the power steering pulley (1).
4. Slowly return the drive belt tensioner to its original position.
5. Remove the drive belt from the remaining pulleys (2-5).

POWER STEERING PUMP REMOVAL

REMOVAL PROCEDURE

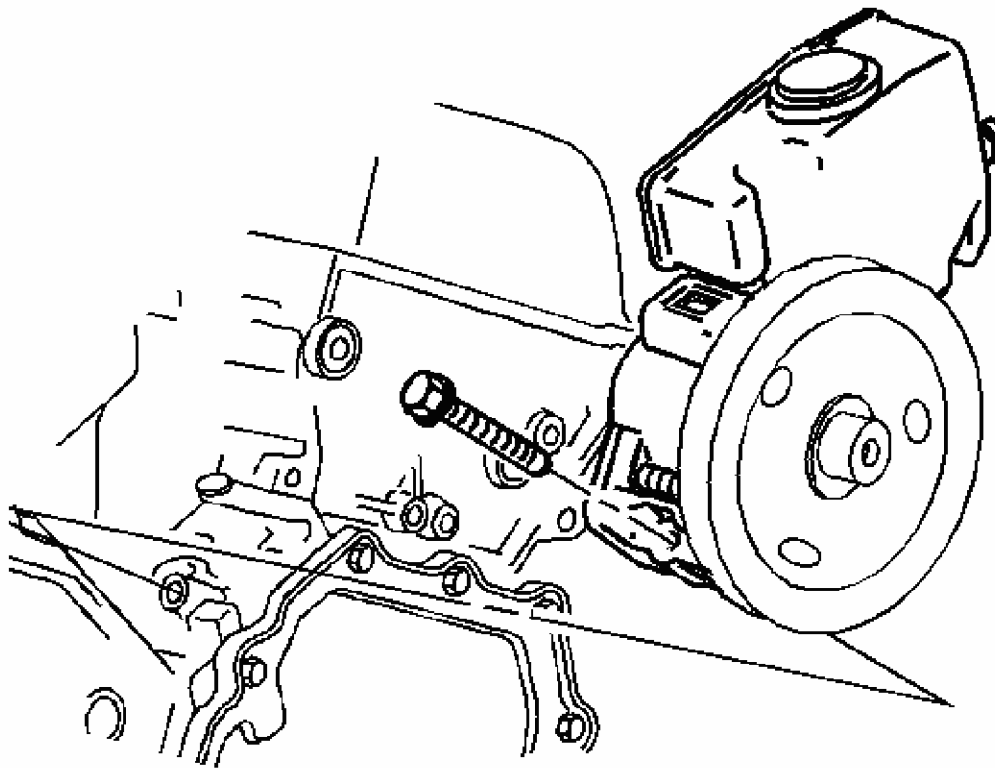


Fig. 172: Identifying Power Steering Pump Retaining Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the power steering pump bolt. The bolt is located perpendicular to the crankshaft centerline and behind the power steering pulley.
2. Remove the power steering pump.

GENERATOR REMOVAL

REMOVAL PROCEDURE

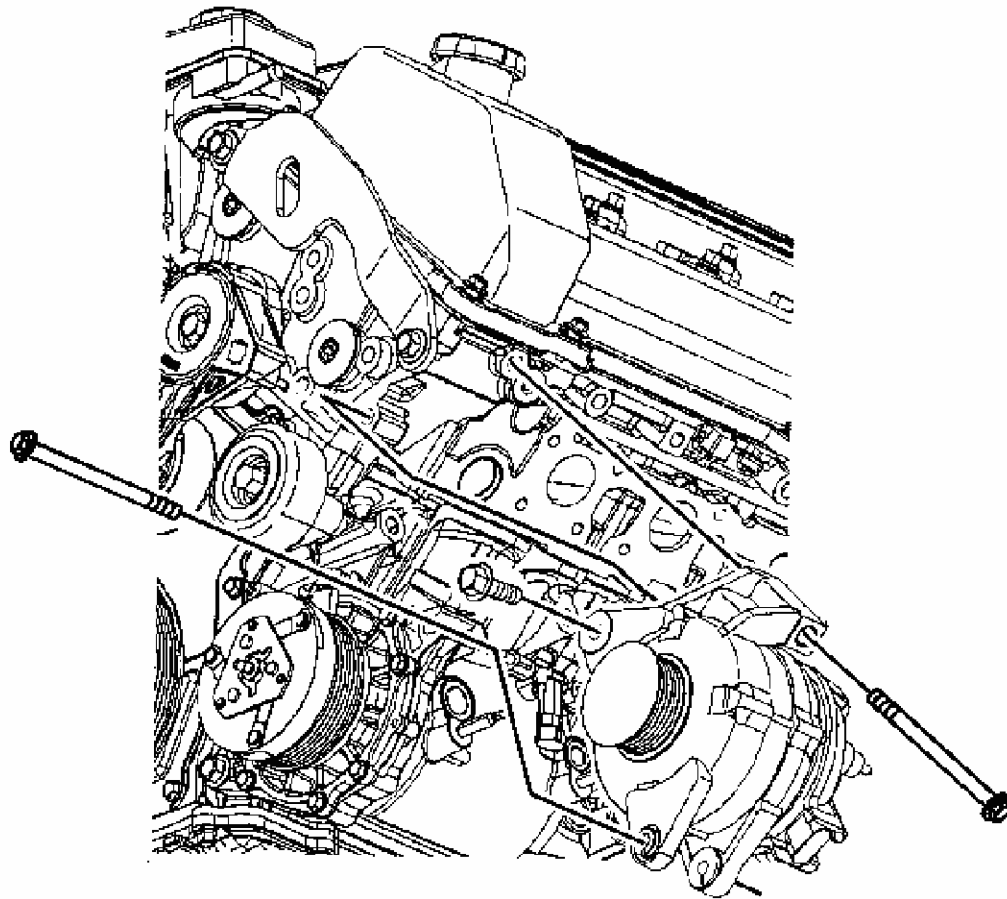


Fig. 173: Identifying Generator Front & Side Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the generator front bolts from the generator.
2. Remove the generator side bolts from the generator.
3. Remove the generator.

AIR CONDITIONING (A/C) COMPRESSOR REMOVAL

REMOVAL PROCEDURE

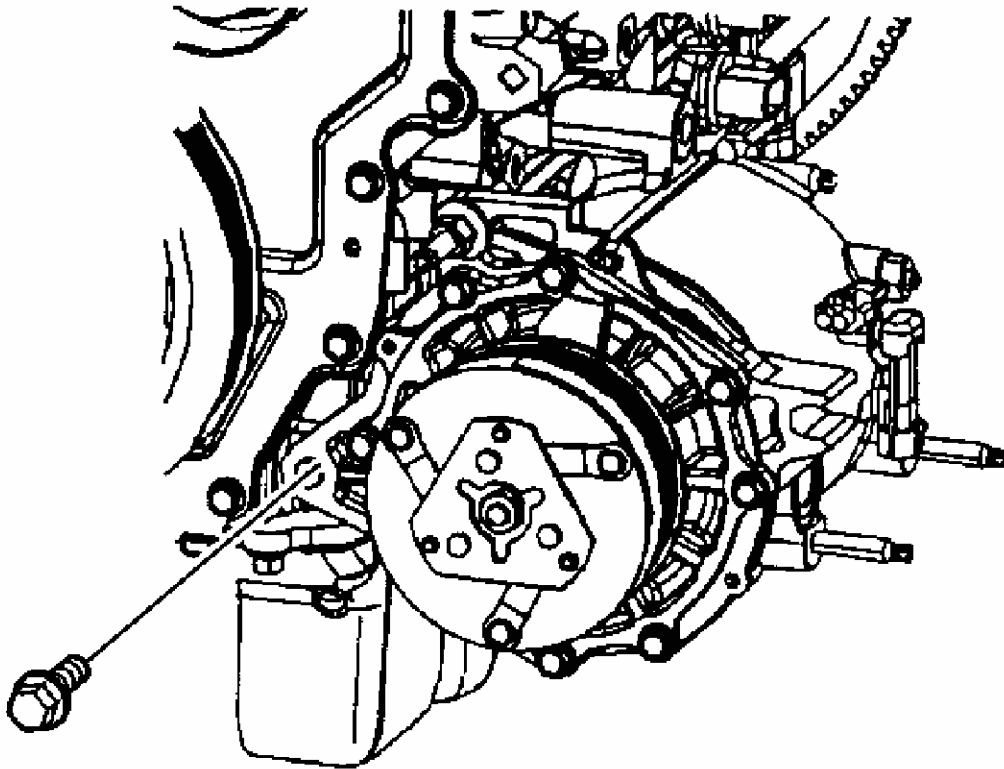


Fig. 174: View of Air Conditioning Compressor Front Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the air conditioning compressor front mounting bolts.

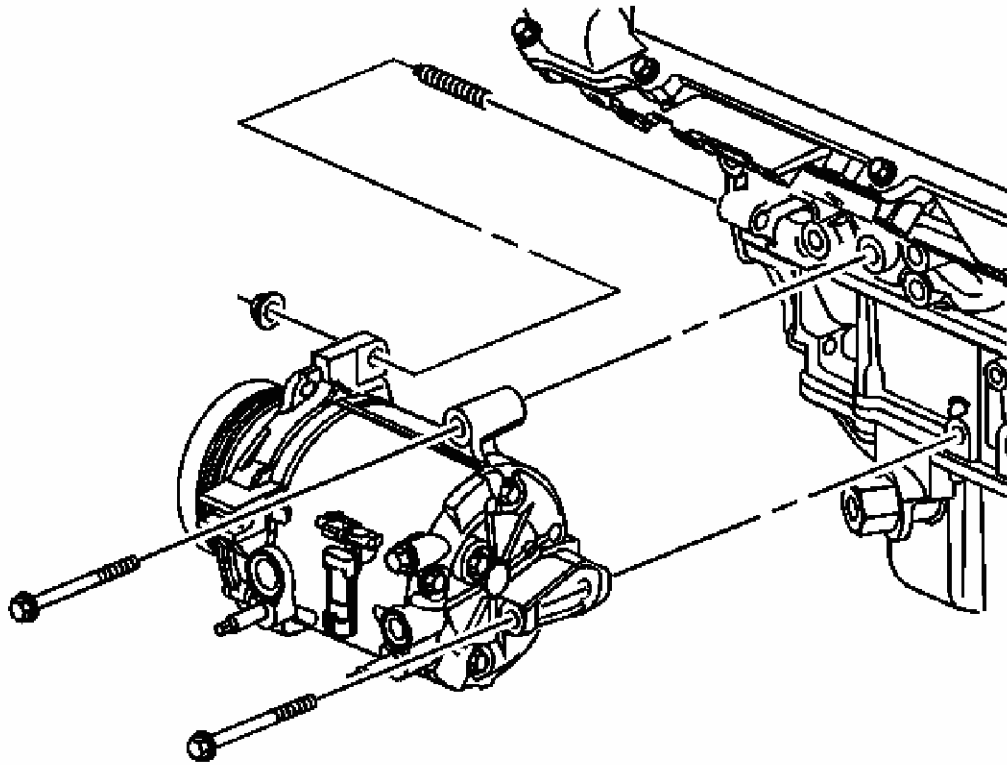


Fig. 175: View of Air Conditioning Compressor Nut
Courtesy of GENERAL MOTORS CORP.

2. Remove the air conditioning compressor nut from the engine block front stud.
3. Remove the air conditioning compressor side bolts from the engine block.
4. Remove the air conditioning compressor by sliding off the front mounting stud.
5. Remove the air conditioning compressor mounting stud.

DRIVE BELT IDLER PULLEY REMOVAL

REMOVAL PROCEDURE

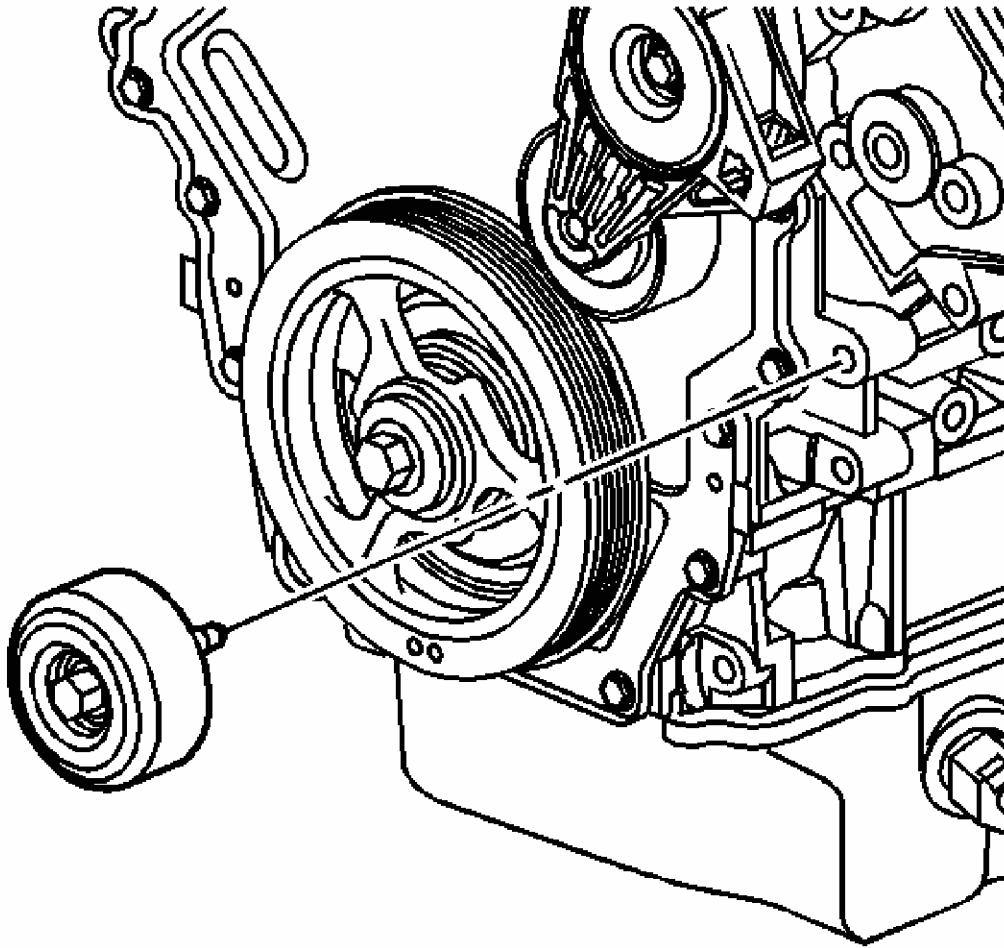


Fig. 176: View of Drive Belt Idler Pulley Bolt
Courtesy of GENERAL MOTORS CORP.

1. Loosen the drive belt idler pulley bolt.
2. Remove the drive belt idler pulley and bolt.

DRIVE BELT TENSIONER REMOVAL

REMOVAL PROCEDURE

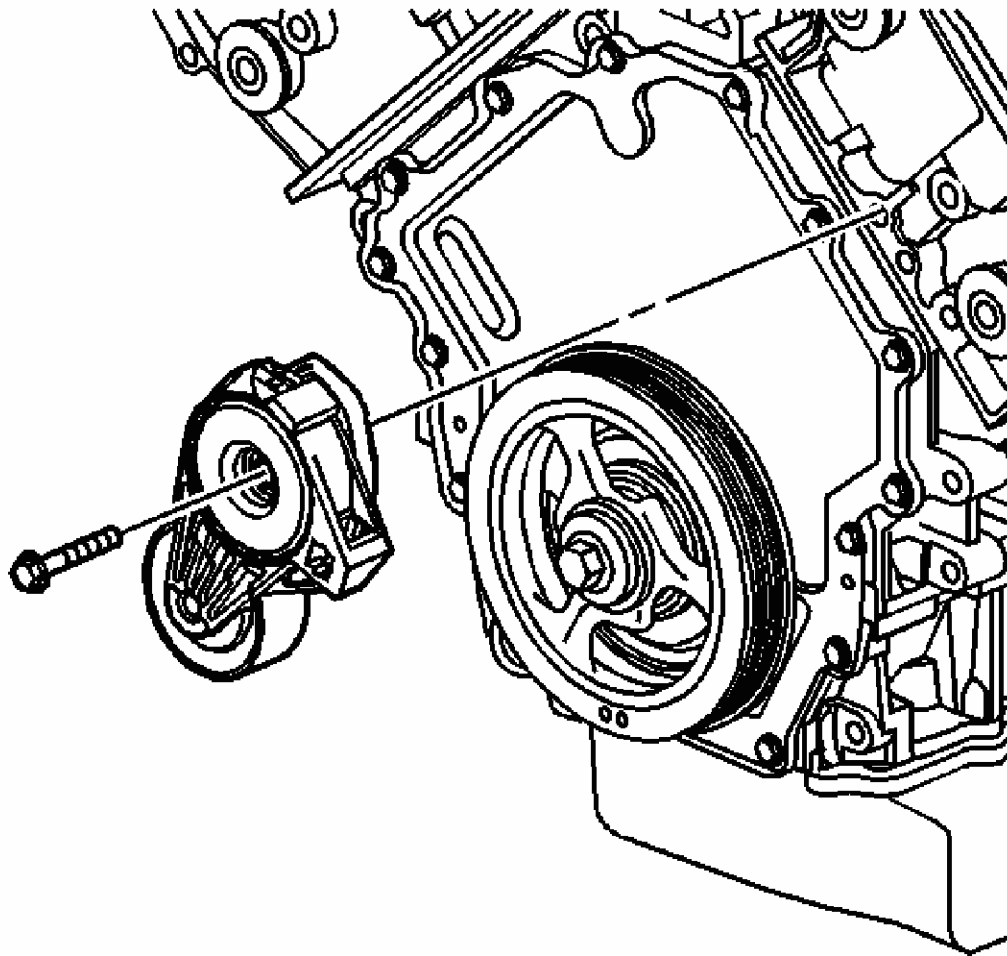


Fig. 177: Identifying Drive Belt Tensioner Bolt
Courtesy of GENERAL MOTORS CORP.

1. Loosen the drive belt tensioner bolt.
2. Remove the drive belt tensioner.

CRANKSHAFT BALANCER REMOVAL

TOOLS REQUIRED

- **J 38416-2** Crankshaft Button. See Special Tools .
- **J 41816** Crankshaft Balancer Remover. See Special Tools .
- **J 44214** Flywheel Holder. See Special Tools .

REMOVAL PROCEDURE

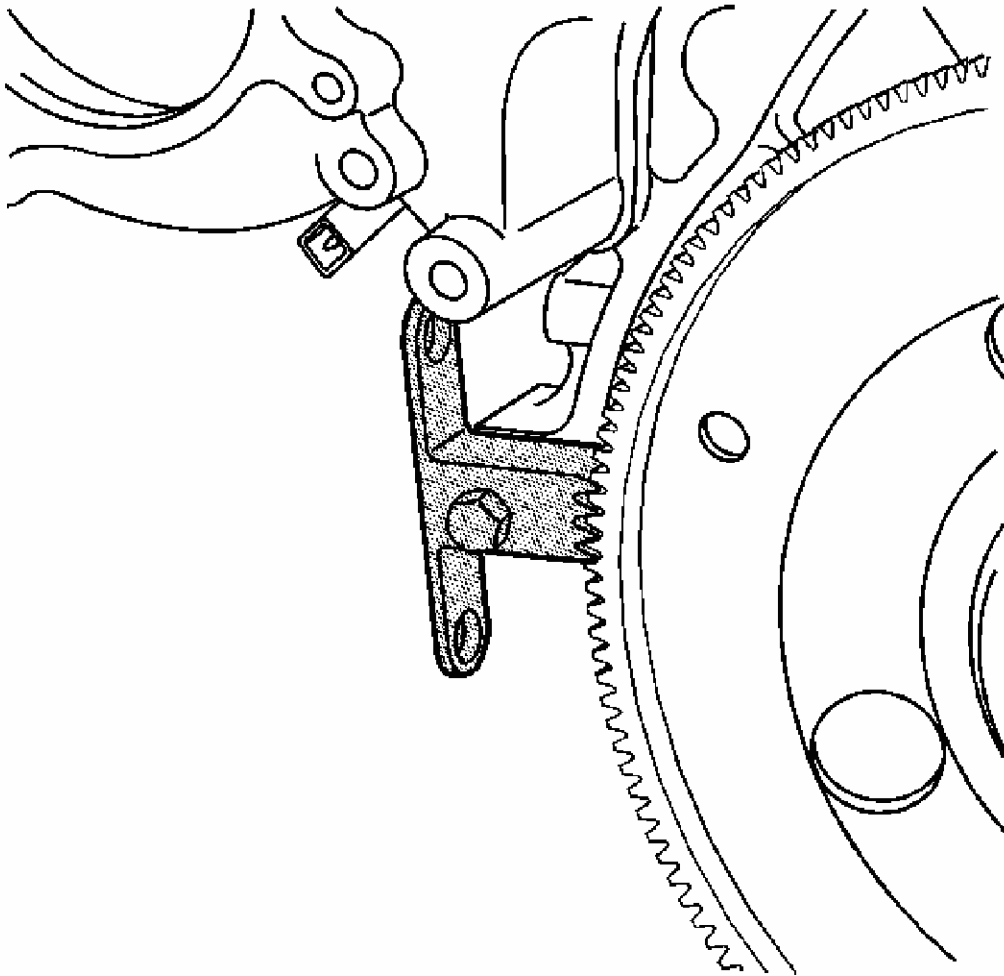


Fig. 178: View of J 44214 Holding Flywheel Ring Gear
Courtesy of GENERAL MOTORS CORP.

1. Install the **J 44214** to the engine block. See **Special Tools** .
2. Secure the flywheel in order to prevent crankshaft rotation.

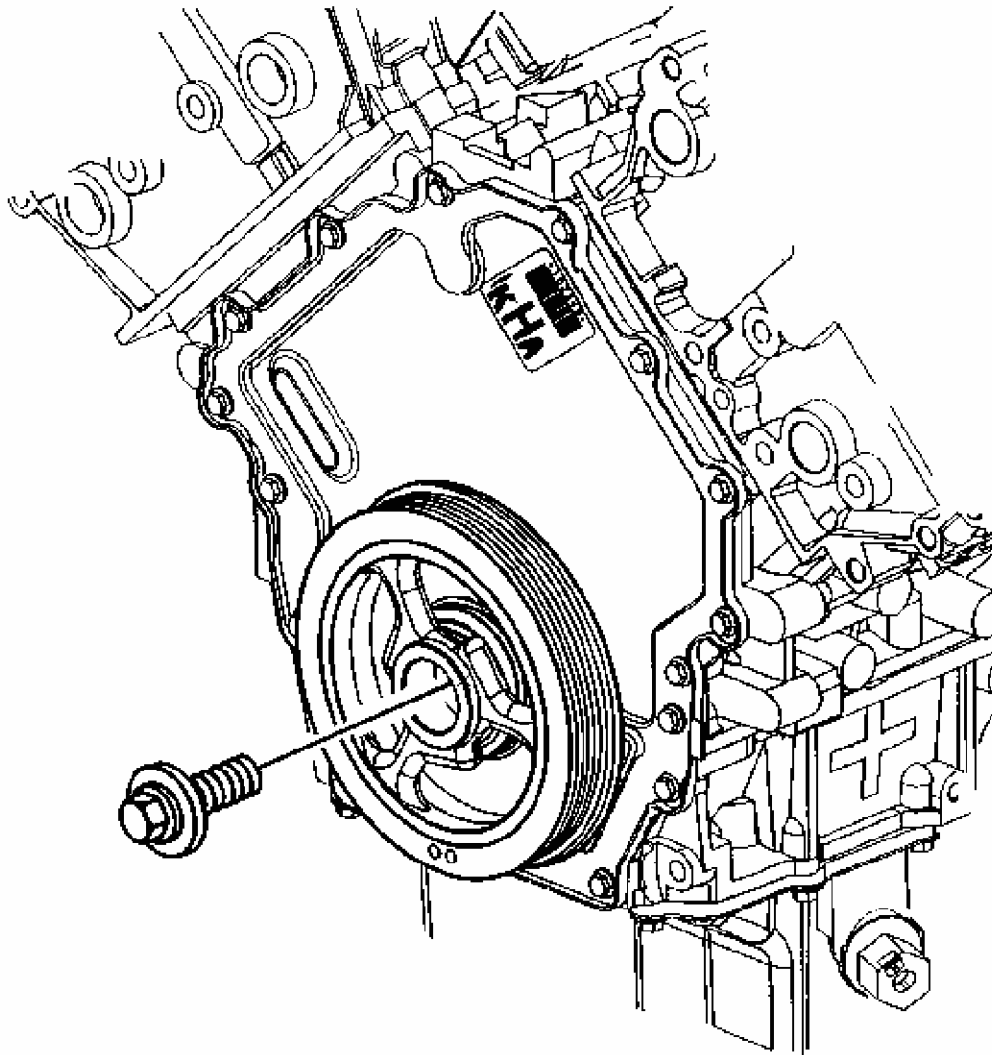


Fig. 179: View of Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the crankshaft balancer bolt.

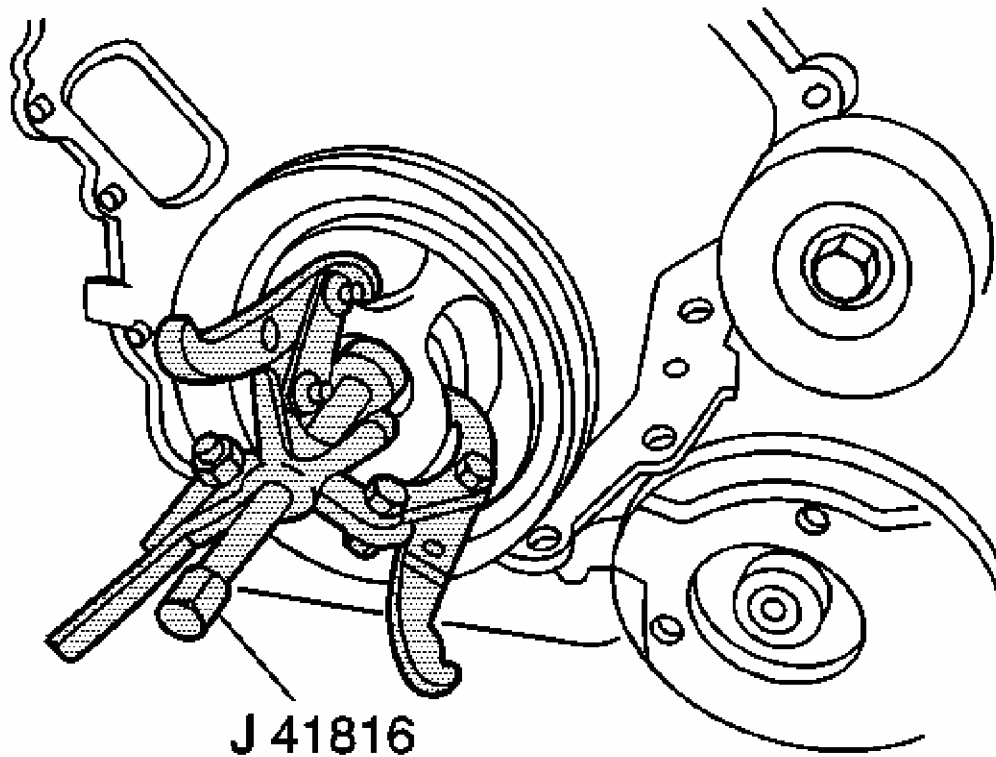


Fig. 180: View of J 41816 Removing Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

4. Place the **J 38416-2** in the end of the crankshaft. See **Special Tools** .
5. Position the legs of the **J 41816** onto the backside of the balancer inner hub. See **Special Tools** .
6. Tighten the center screw on the puller until the balancer pulls clear of the crankshaft end.

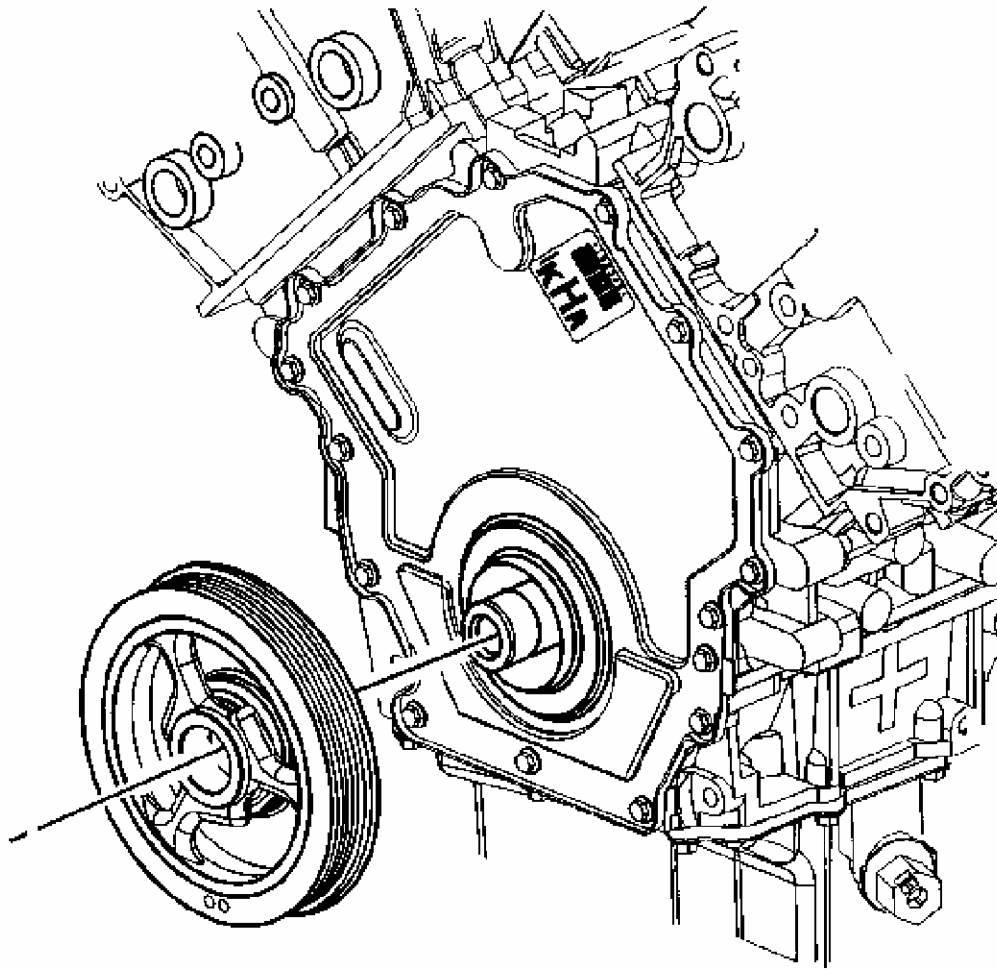


Fig. 181: View of Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft balancer.

ENGINE FLYWHEEL REMOVAL

TOOLS REQUIRED

J 44214 Flywheel Holder. See Special Tools .

REMOVAL PROCEDURE

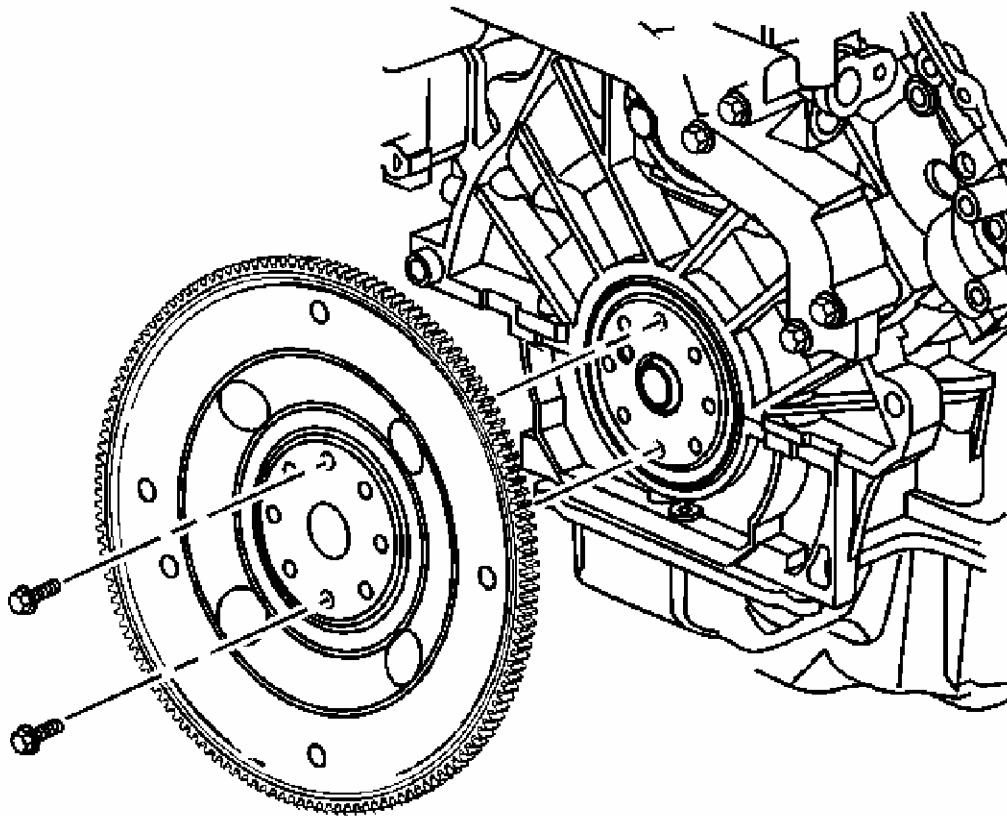


Fig. 182: Identifying 8 Engine Flywheel Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

1. Loosen the 8 engine flywheel mounting bolts.
2. Remove 7 of the 8 engine flywheel bolts leaving 1 bolt at the top of the crankshaft rotation.
3. Grip the engine flywheel and remove the remaining bolt. Do not drop the engine flywheel when removing the final bolt.

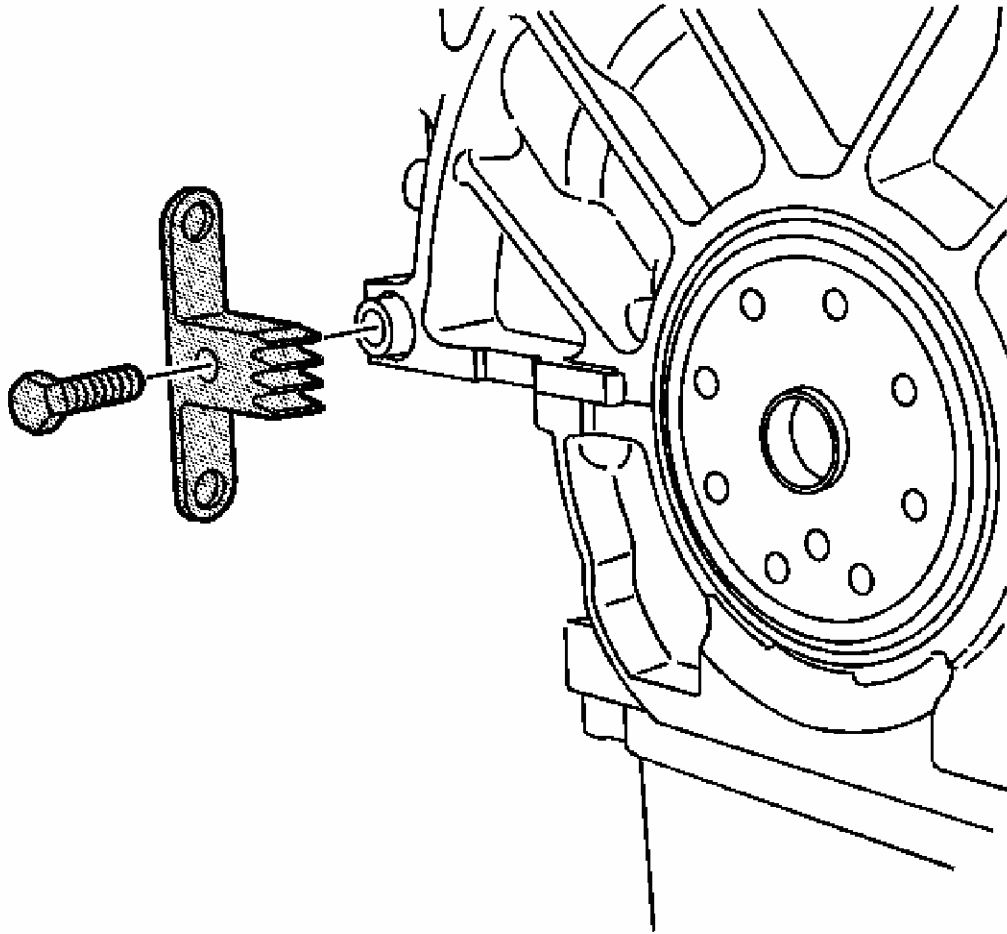


Fig. 183: View Of J 44214 & Engine Block
Courtesy of GENERAL MOTORS CORP.

4. Remove the **J 44214** from the engine block. See **Special Tools** .

CRANKSHAFT REAR OIL SEAL REMOVAL

TOOLS REQUIRED

J 42841-A Rear Oil Seal Remover. See **Special Tools** .

REMOVAL PROCEDURE

IMPORTANT: Although originally equipped with a lip-style crankshaft rear oil seal, engines built from March 1, 1996 and thru

1999 should now use the cassette-style crankshaft rear oil seal.

IMPORTANT: If the engine is in the vehicle, the crankshaft rear oil seal can be removed/installed after the transmission/transaxle and engine flywheel are removed.

IMPORTANT: Crankshaft rear oil seal removal requires adequate space for removal. Mount the engine on a suitable engine stand which will properly space the engine in order to use the J 42841-A in order to remove the crankshaft rear oil seal. See Special Tools . If necessary, remove the crankshaft rear oil seal with the engine properly supported on the floor or on a bench.

IMPORTANT: Beginning with the model year 2006 the flywheel/flexplate crankshaft bolt hole thread was changed from 8 x 1.25 mm to 11 x 1.5 mm. The J 42841-A will service the cassette seals installed on engines from March 1, 1996 and later. See Special Tools . If the older J 42841 is to be used on a 2006 or later engine the update kit, J 42841-10, must be used to convert the J 42841 to a J 42841-A . See Special Tools .

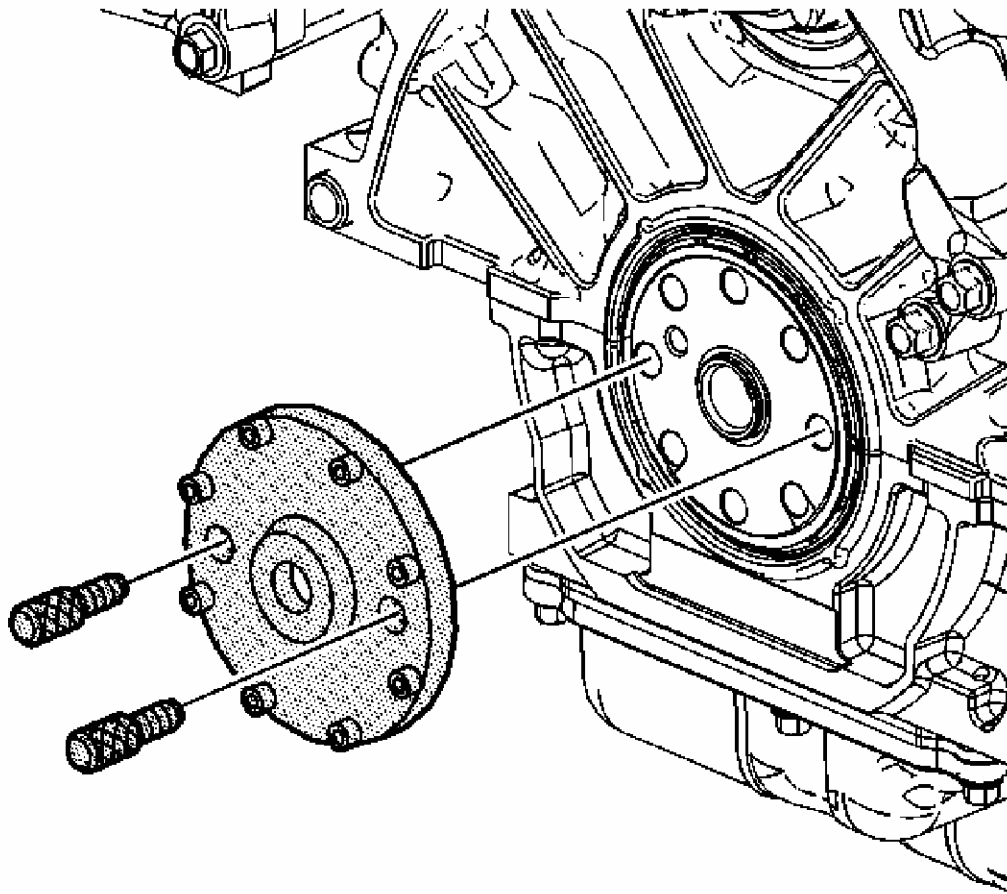


Fig. 184: View Of J 42841 & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the **J 42841-A** plate onto the crankshaft. See **Special Tools** . The hub on the crankshaft will fit into the recess on the inboard side of the **J 42841-A** plate. See **Special Tools** .

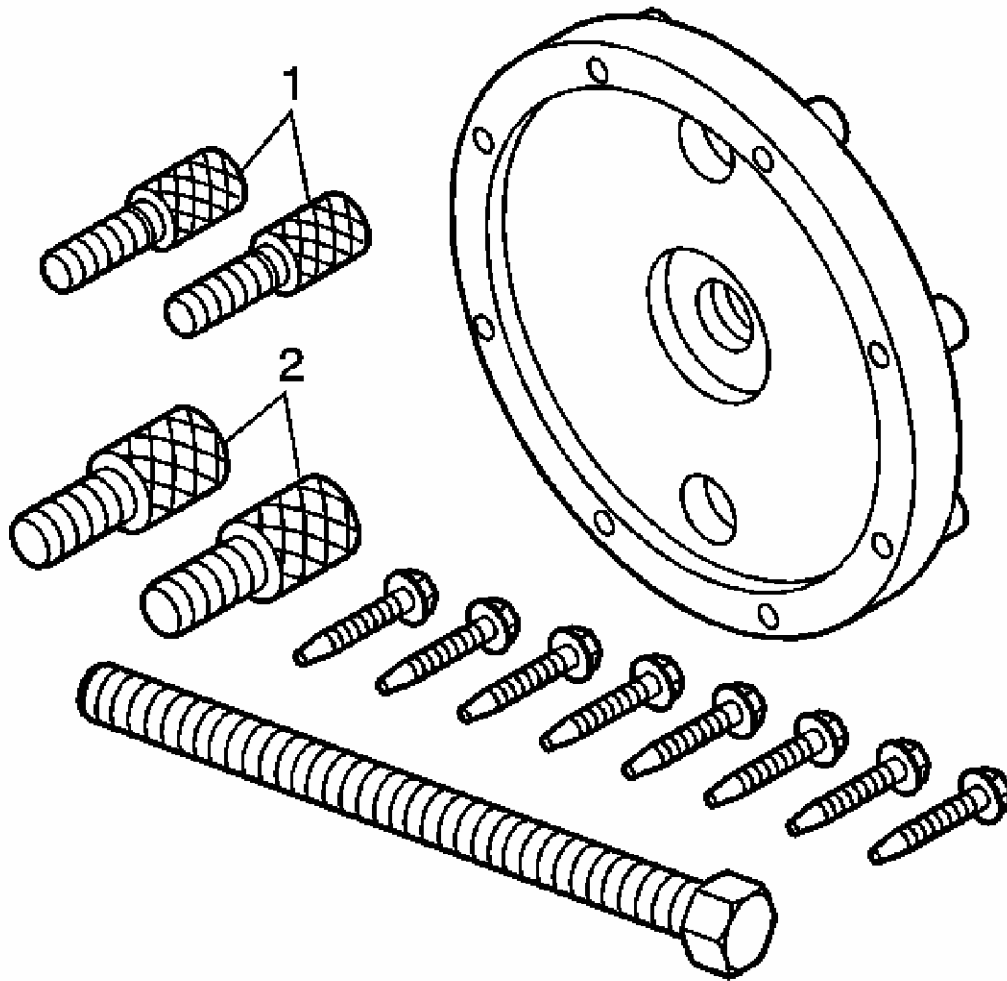


Fig. 185: Identifying J 42841 Crankshaft Rear Oil Seal Remover
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Northstar engines 2005 and older have an 8 x 1.25 mm flywheel/flexplate crankshaft bolt hole thread. Northstar engines 2006 and later have an 11 x 1.5 mm flywheel/flexplate crankshaft bolt hole thread.

2. Use the proper bolts from the **J 42841-A** to retain the plate in place. See **Special Tools** . Use the bolts (1) 8 mm or the bolts (2) 11 mm.

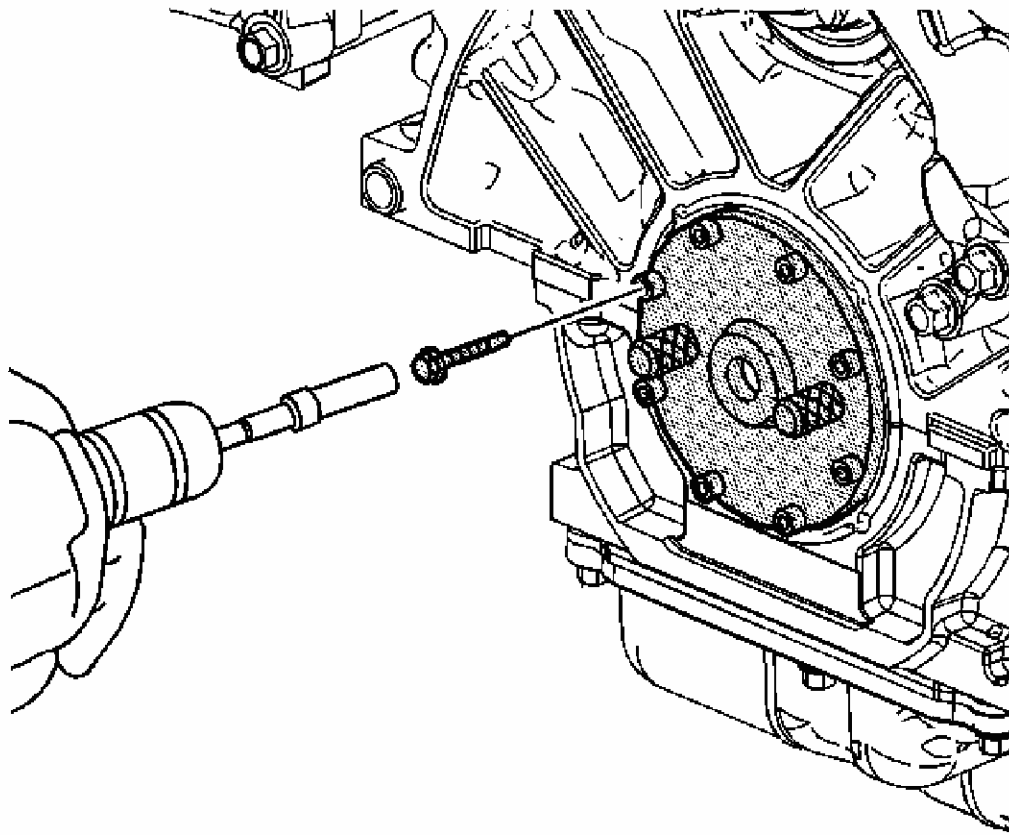


Fig. 186: Installing Screws Into Guide Holes
Courtesy of GENERAL MOTORS CORP.

3. Using a drill motor, variable speed preferred, with a socket adapter, install eight 25 mm (1.0 in) self-drilling screws into the seal using the guide holes in the removal tool. When drilling, ensure the drill motor speed is reduced when the screw begins threading into the seal.

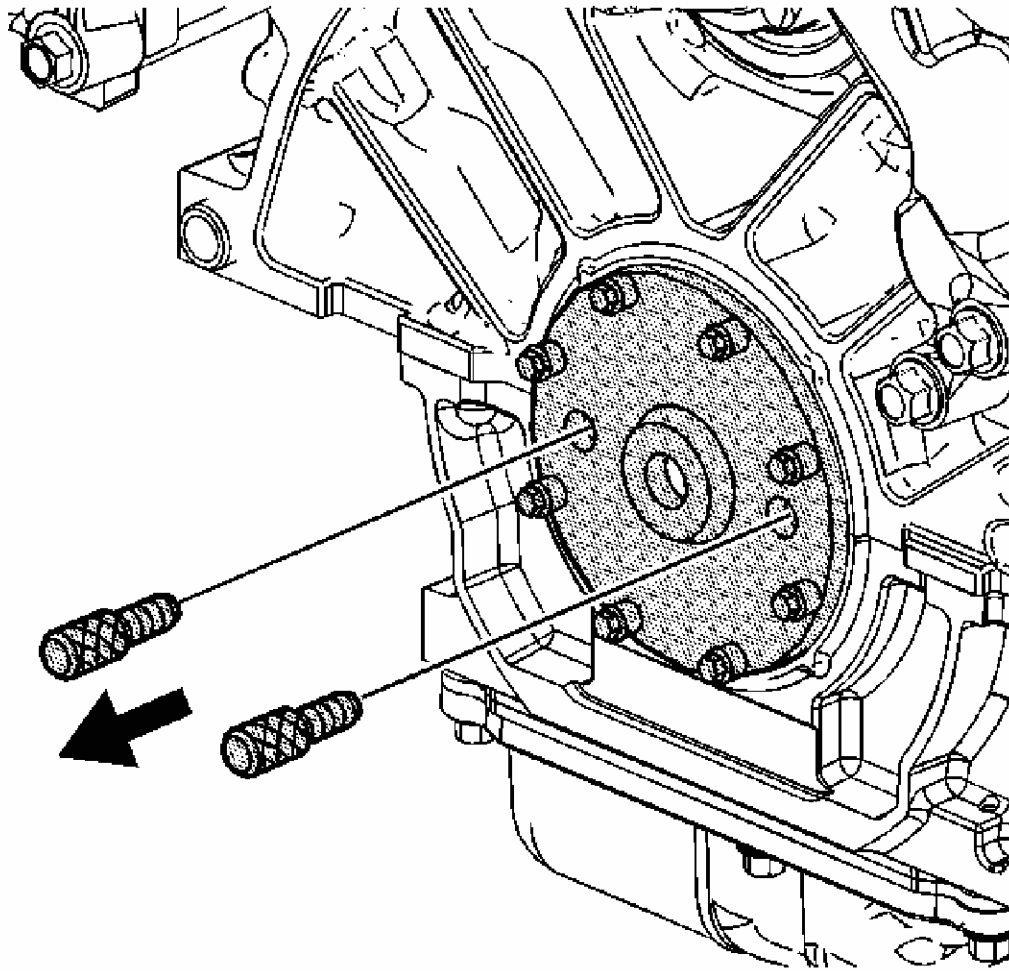


Fig. 187: View Of J 42841 Forcing Screw
Courtesy of GENERAL MOTORS CORP.

4. With all eight removal screws installed, remove the **J 42841-A** retaining bolts. See **Special Tools** .

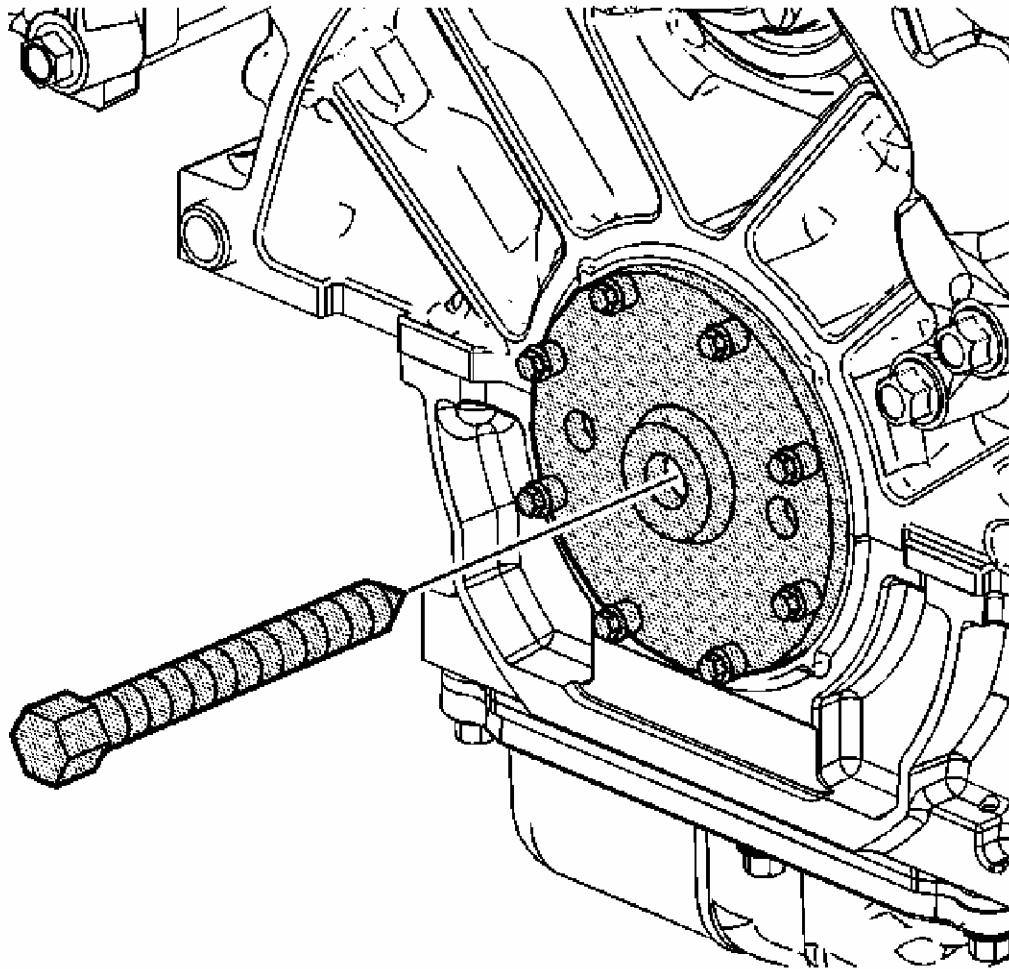


Fig. 188: Identifying J 42841 Center Forcing Screw
Courtesy of GENERAL MOTORS CORP.

5. Install the center forcing screw.

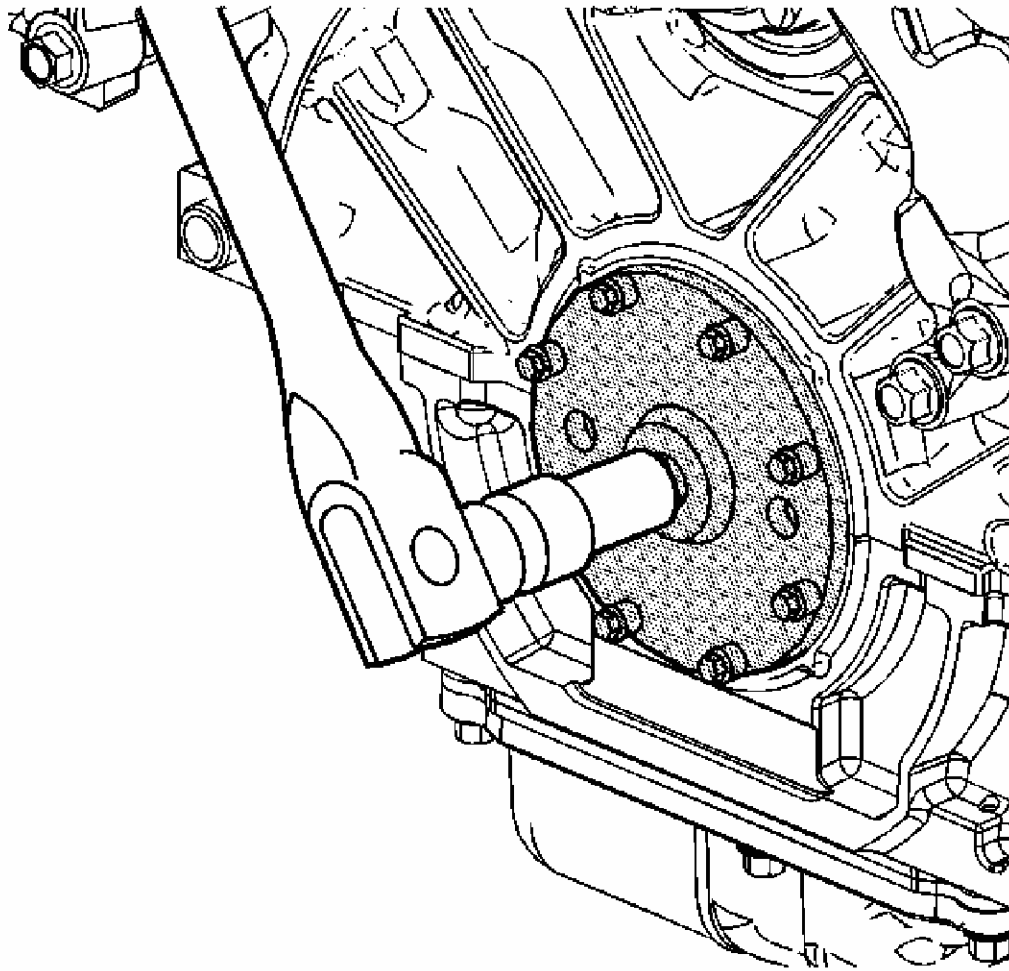


Fig. 189: Removing J 42841 from Crankshaft
Courtesy of GENERAL MOTORS CORP.

6. Tighten the center screw on the **J 42841-A** in order to pull the seal assembly off the end of the crankshaft. See **Special Tools** .

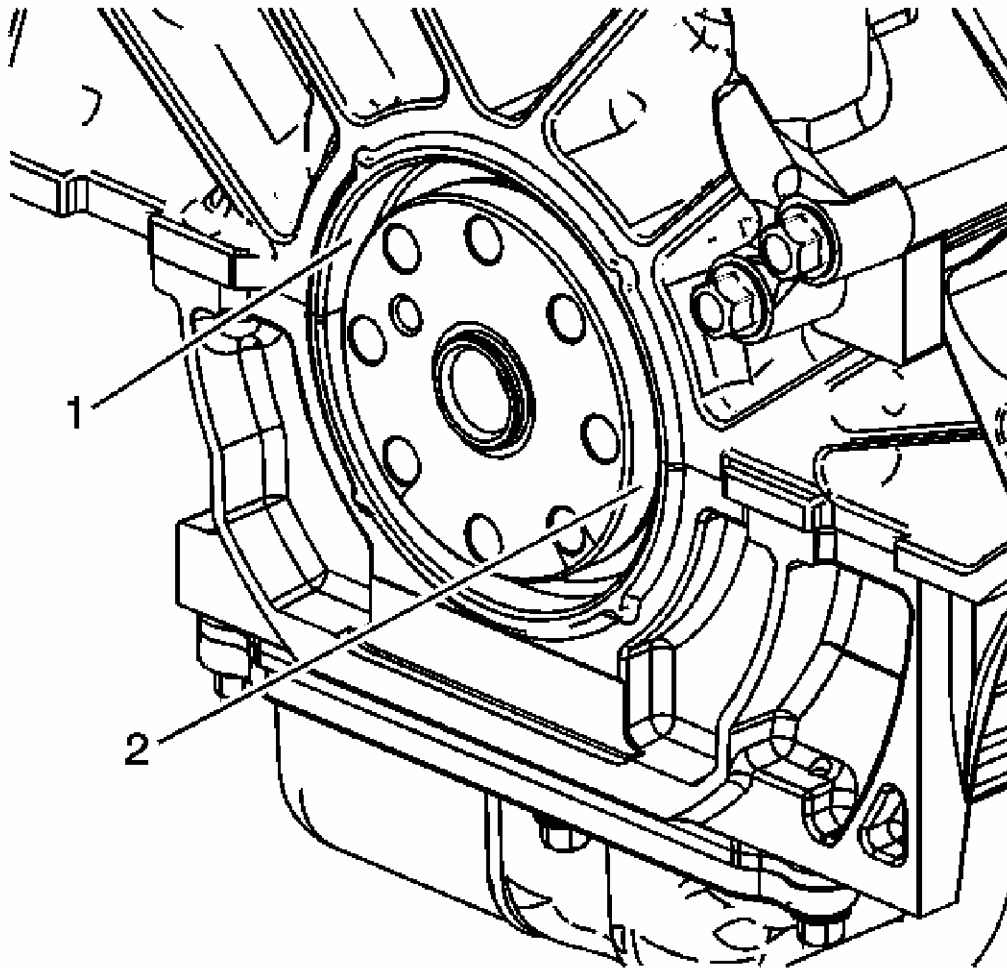


Fig. 190: Identifying Rear Crankshaft Seal Bore & Flange
Courtesy of GENERAL MOTORS CORP.

7. After removing the crankshaft rear oil seal inspect the engine block bore (1) and the crankshaft flange (2) for the damage. Repair or replace any damaged components.

OIL LEVEL INDICATOR AND TUBE REMOVAL

REMOVAL PROCEDURE

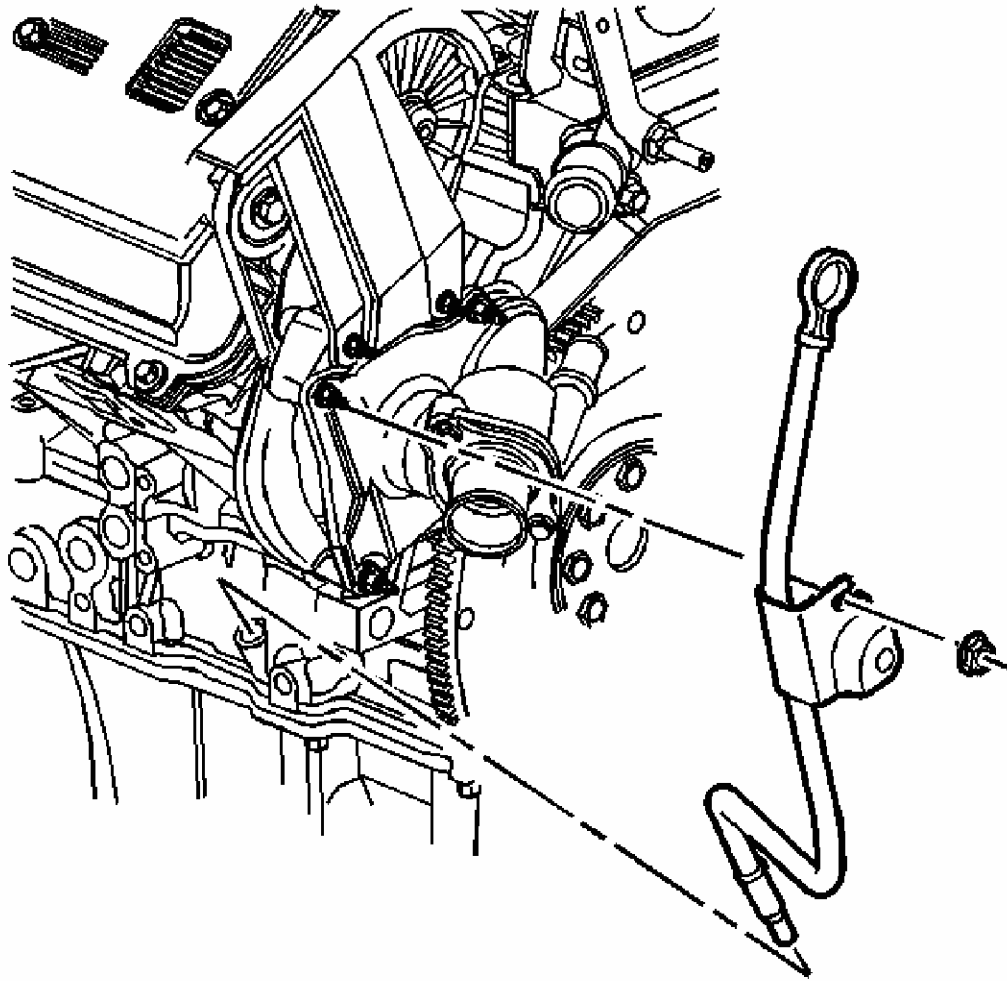


Fig. 191: View of Oil Lever Indicator Tube Nut
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator tube nut.
2. Remove the oil level indicator tube.

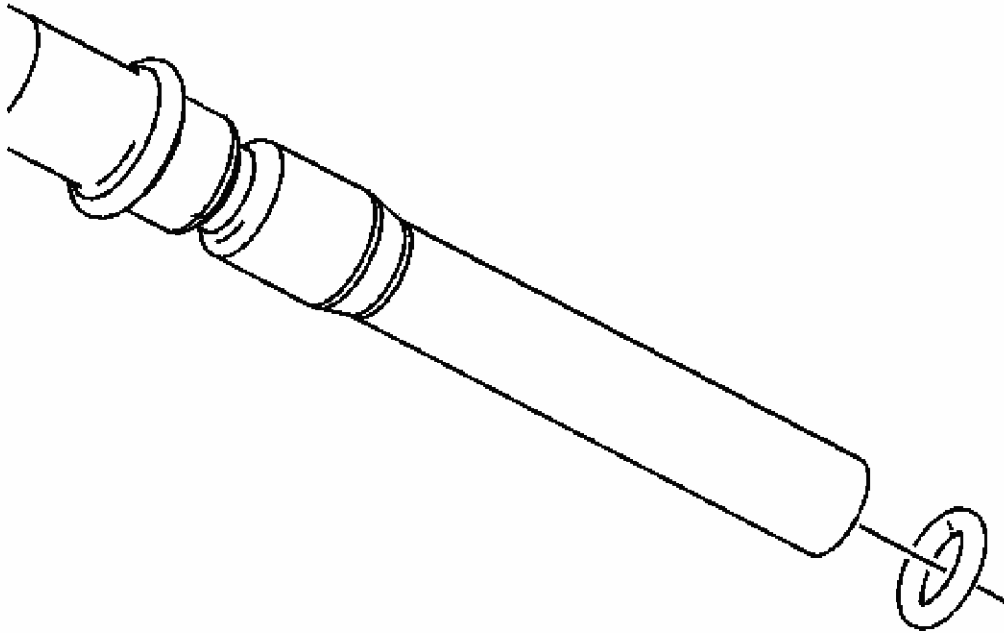


Fig. 192: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the O-ring from the oil level indicator tube.

EXHAUST MANIFOLD REMOVAL - LEFT SIDE (W/O RPO NC1 OR NF7)

REMOVAL PROCEDURE

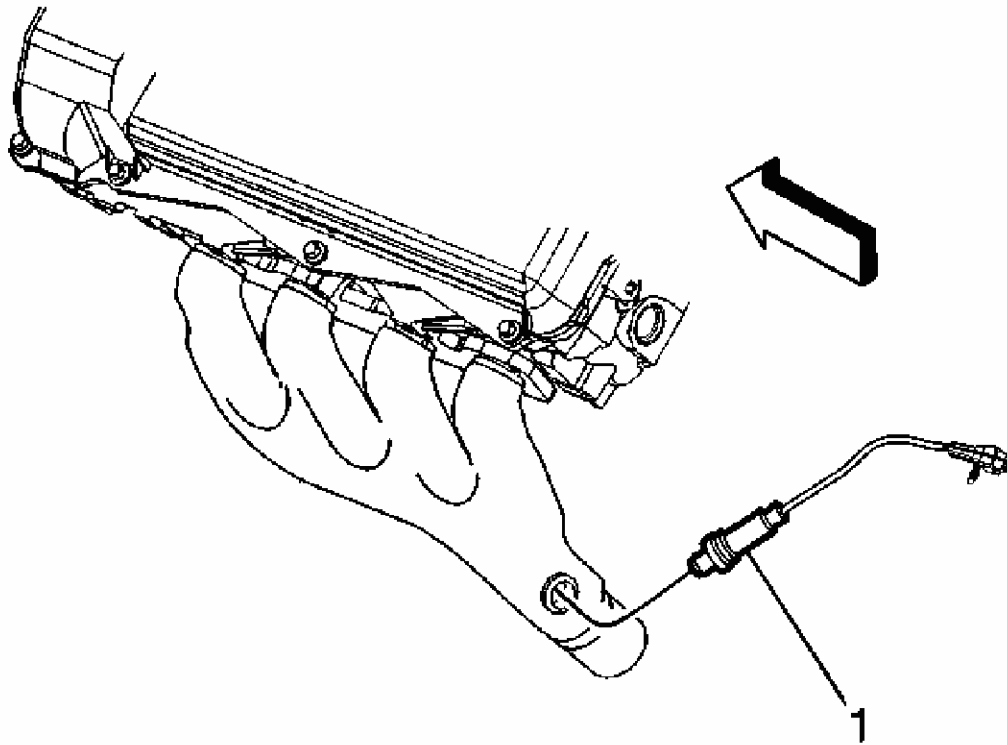


Fig. 193: Identifying Oxygen Sensor
Courtesy of GENERAL MOTORS CORP.

1. Remove the oxygen sensor (1) and inspect the sensor for excessive deposits or damage. Replace the oxygen sensor if necessary.

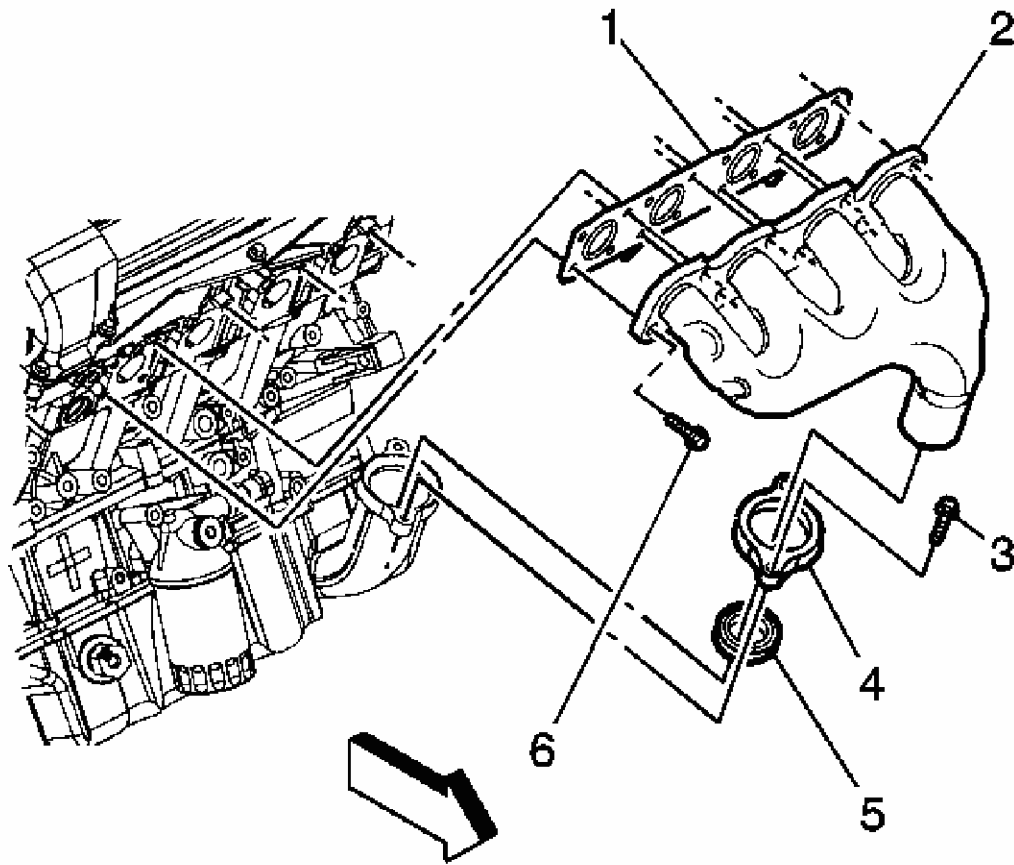


Fig. 194: Identifying Left Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

2. Remove the exhaust manifold to exhaust intermediate pipe bolts (3).
3. Remove the exhaust manifold bolts (6).
4. Remove the exhaust manifold (2).

IMPORTANT: DO NOT reuse the exhaust manifold to exhaust intermediate pipe gasket.

5. Remove and discard the exhaust manifold to exhaust intermediate pipe gasket (5).

IMPORTANT: DO NOT reuse the exhaust manifold gasket.

6. Remove and discard the exhaust manifold gasket (1).

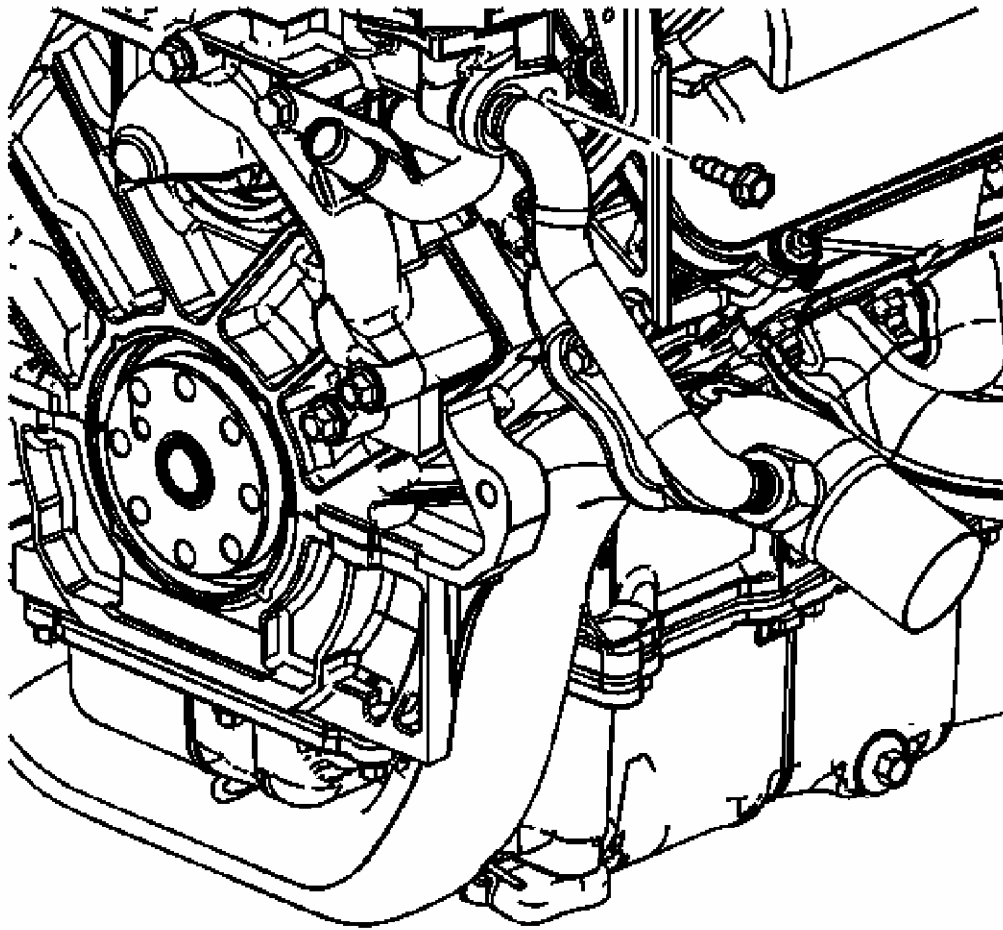


Fig. 195: Identifying EGR Valve Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

7. Remove the exhaust gas recirculation (EGR) valve inlet pipe bolt from the water crossover.

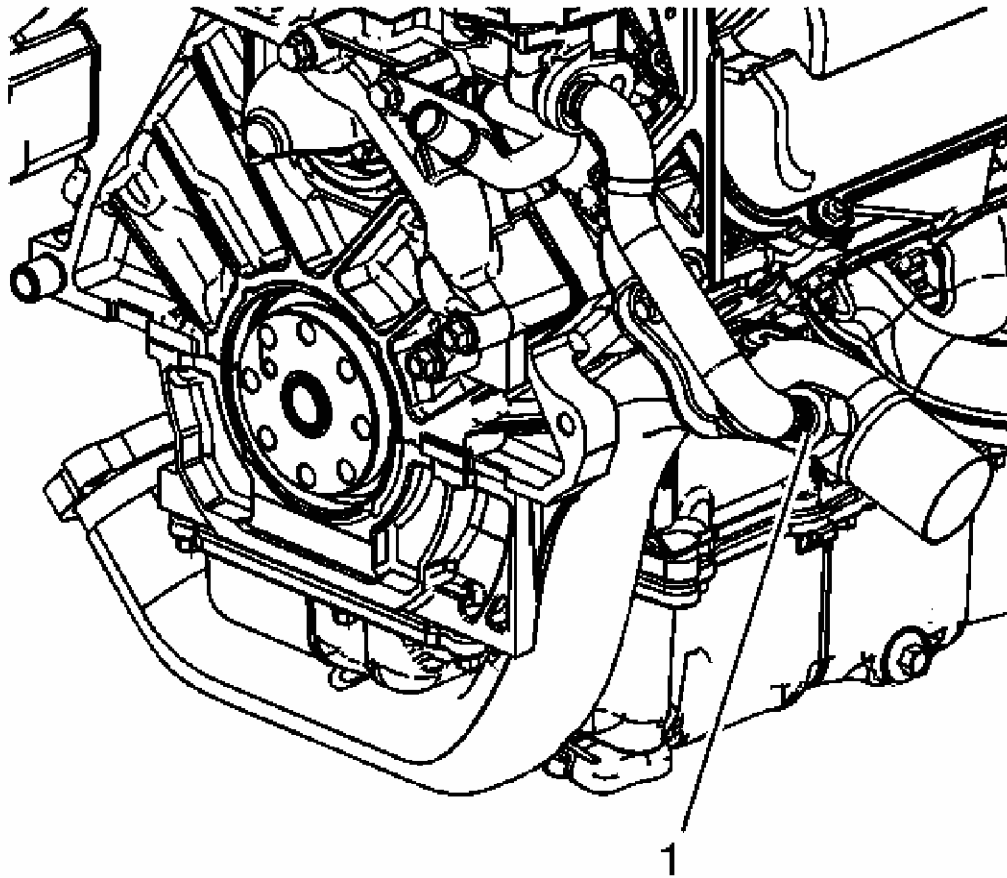


Fig. 196: Identifying EGR Valve Inlet Pipe Nut
Courtesy of GENERAL MOTORS CORP.

8. Disconnect the EGR valve inlet pipe nut (1) from the fitting on the exhaust intermediate pipe.

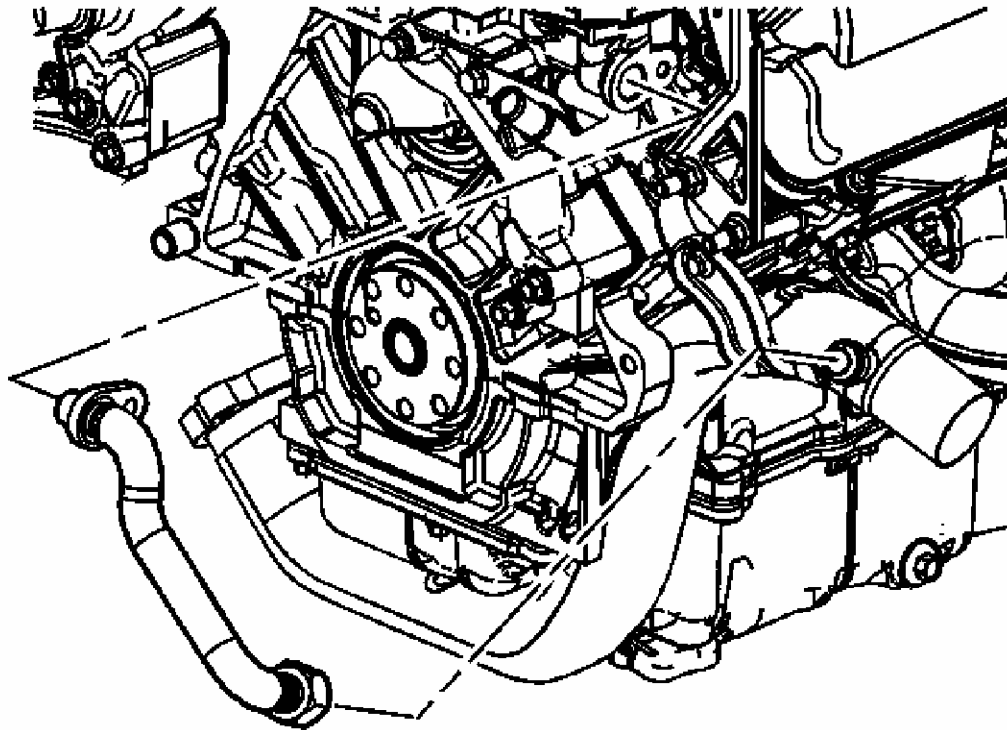


Fig. 197: Identifying EGR Valve Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

9. Remove and discard the EGR valve inlet pipe.

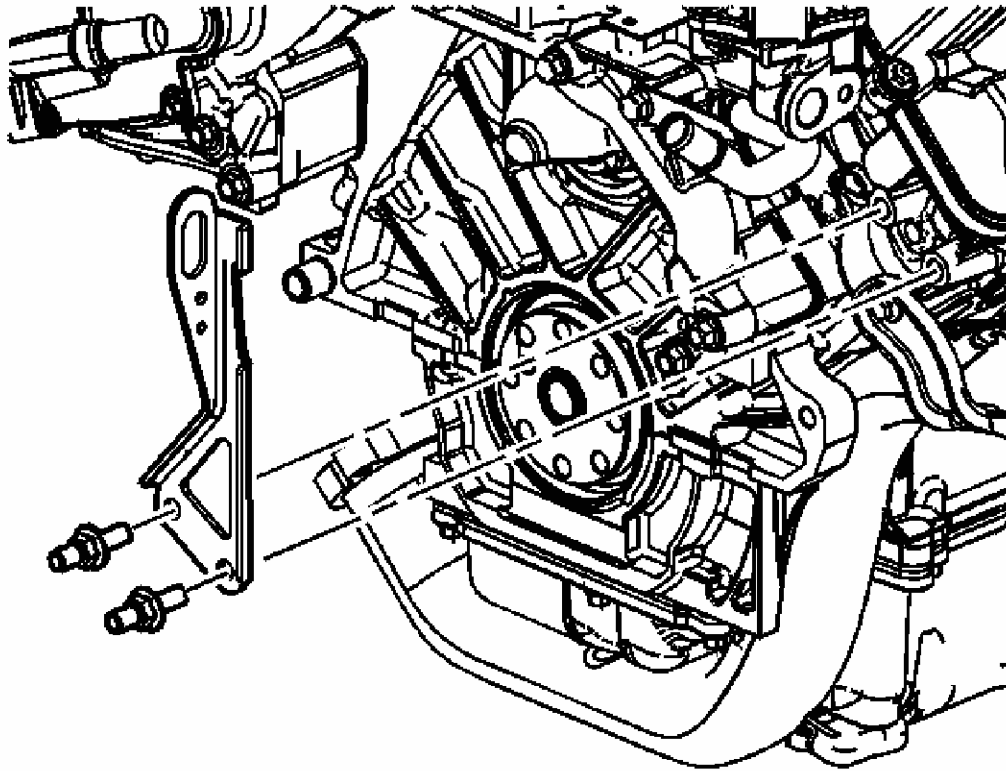


Fig. 198: Identifying Engine Rear Lift Bracket
Courtesy of GENERAL MOTORS CORP.

10. Remove the engine rear lift bracket bolts.
11. Remove the engine rear lift bracket.

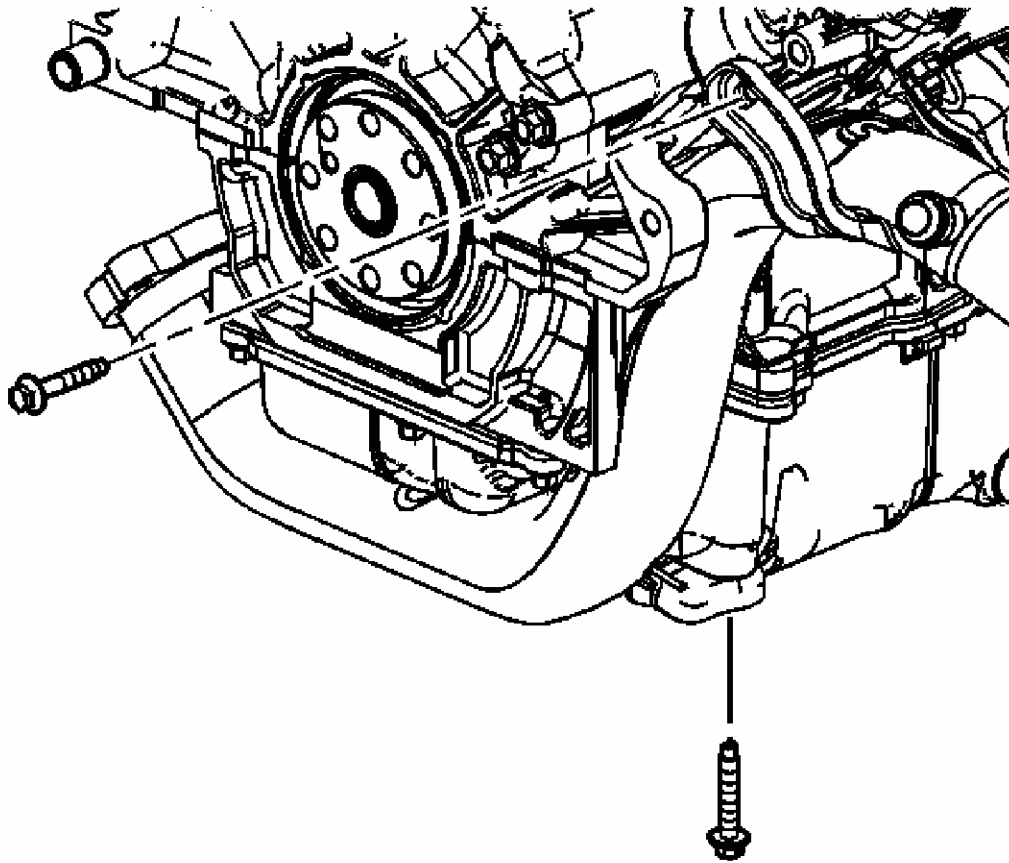


Fig. 199: View Of Exhaust Intermediate Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

12. Remove the exhaust intermediate pipe bolts.

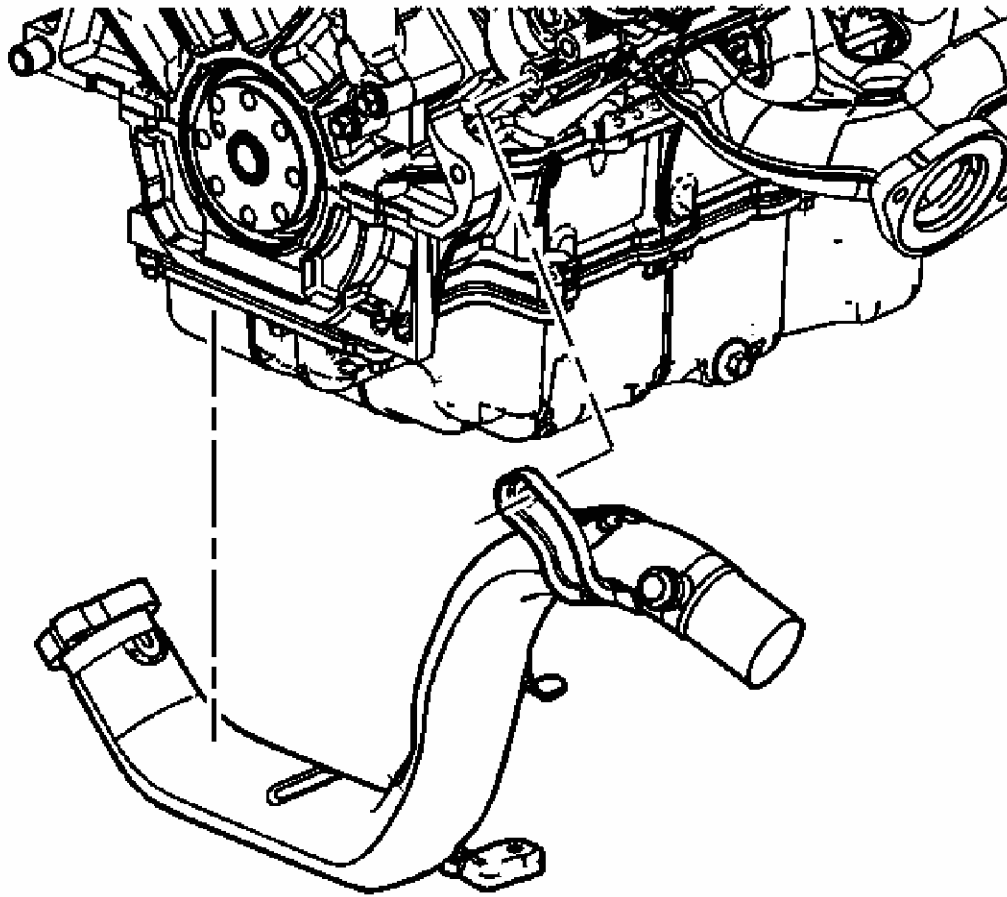


Fig. 200: Identifying Exhaust Intermediate Pipe
Courtesy of GENERAL MOTORS CORP.

13. Remove the exhaust intermediate pipe.

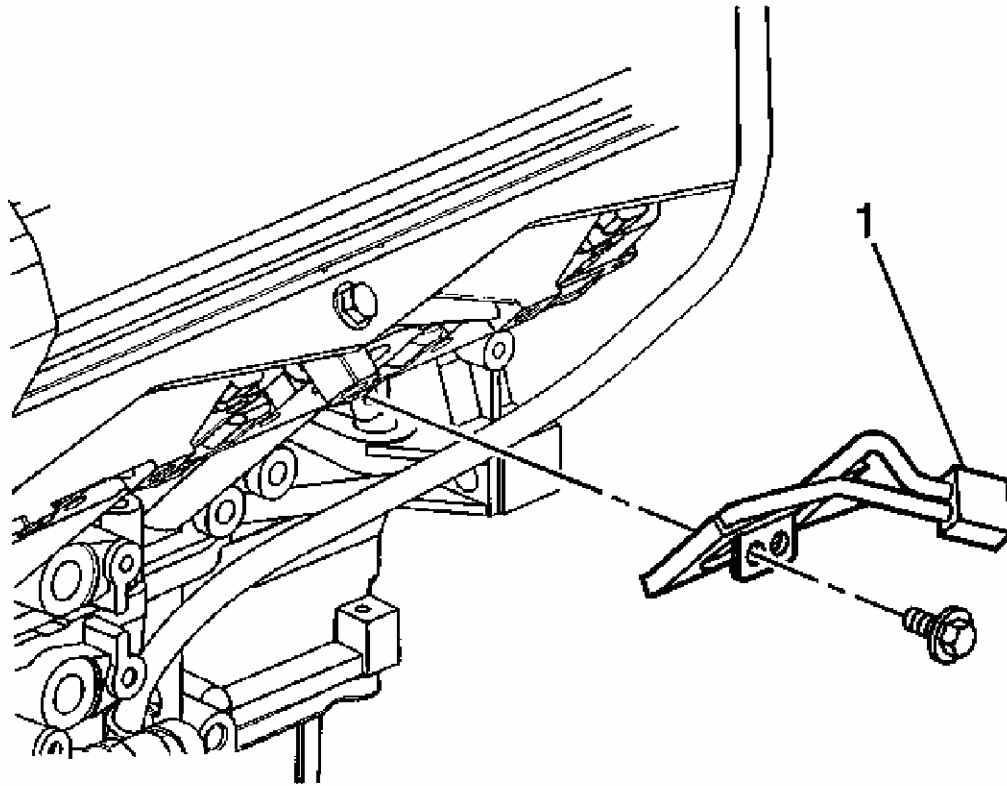


Fig. 201: Locating Left Side Coolant Heater
Courtesy of GENERAL MOTORS CORP.

14. If equipped, remove the left coolant heater (1) as follows:
1. Remove the coolant heater bolt.
 2. Remove the coolant heater from the cylinder block.

EXHAUST MANIFOLD REMOVAL - LEFT SIDE (WITH RPO NC1 OR NF7)

REMOVAL PROCEDURE

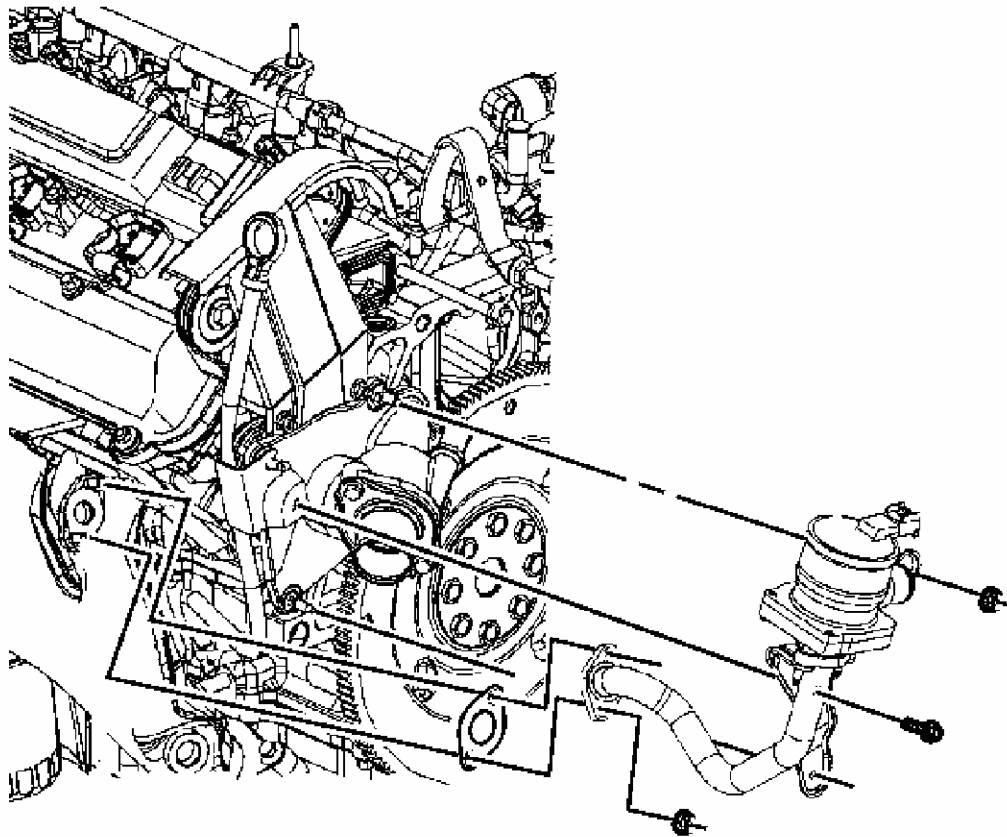


Fig. 202: Identifying Secondary Air Injection (AIR) Valve Pipe
Courtesy of GENERAL MOTORS CORP.

1. Remove the secondary air injection (AIR) valve pipe nuts from the exhaust manifold.
2. Remove the AIR valve bolt from the mounting bracket.
3. Remove the AIR valve nuts from the mounting bracket.
4. Remove the AIR valve.

IMPORTANT: DO NOT reuse the old AIR valve pipe gasket.

5. Remove and discard the AIR valve pipe gasket.

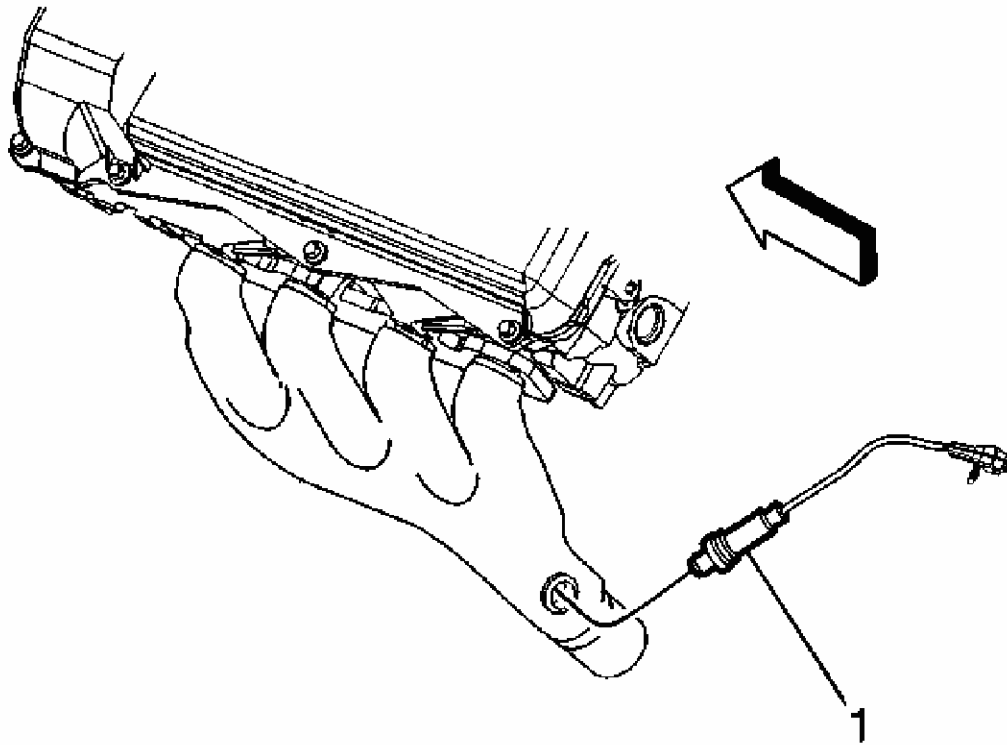


Fig. 203: Identifying Oxygen Sensor
Courtesy of GENERAL MOTORS CORP.

6. Remove the oxygen sensor (1) and inspect the sensor for excessive deposits or damage. Replace the oxygen sensor if necessary.

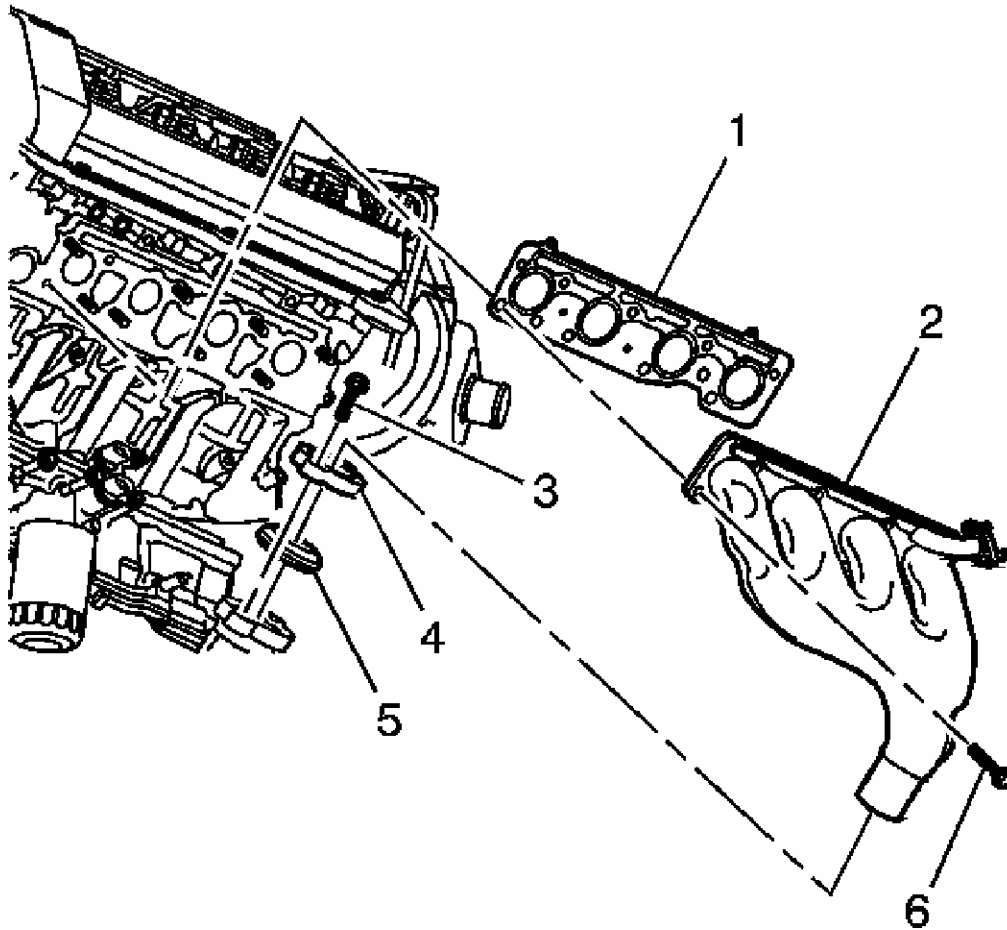


Fig. 204: Identifying Left Exhaust Manifold Components
Courtesy of GENERAL MOTORS CORP.

7. Remove the exhaust manifold to exhaust intermediate pipe bolts (3).
8. Remove the exhaust manifold bolts (6).
9. Remove the exhaust manifold (2).

IMPORTANT: DO NOT reuse the exhaust manifold to exhaust intermediate pipe gasket.

10. Remove and discard the exhaust manifold to exhaust intermediate pipe gasket (5).

IMPORTANT: DO NOT reuse the exhaust manifold gasket.

11. Remove and discard the exhaust manifold gasket (1).

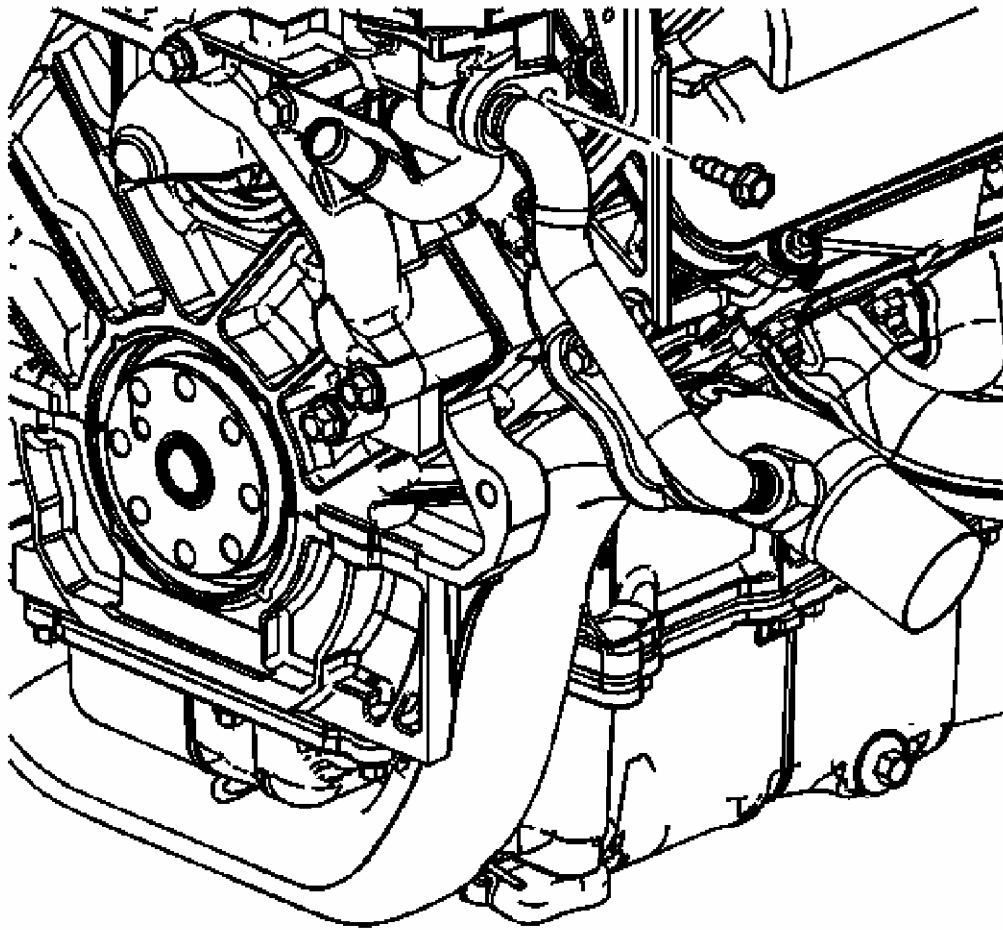


Fig. 205: Identifying EGR Valve Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

12. Remove the exhaust gas recirculation (EGR) valve inlet pipe bolt from the water crossover.

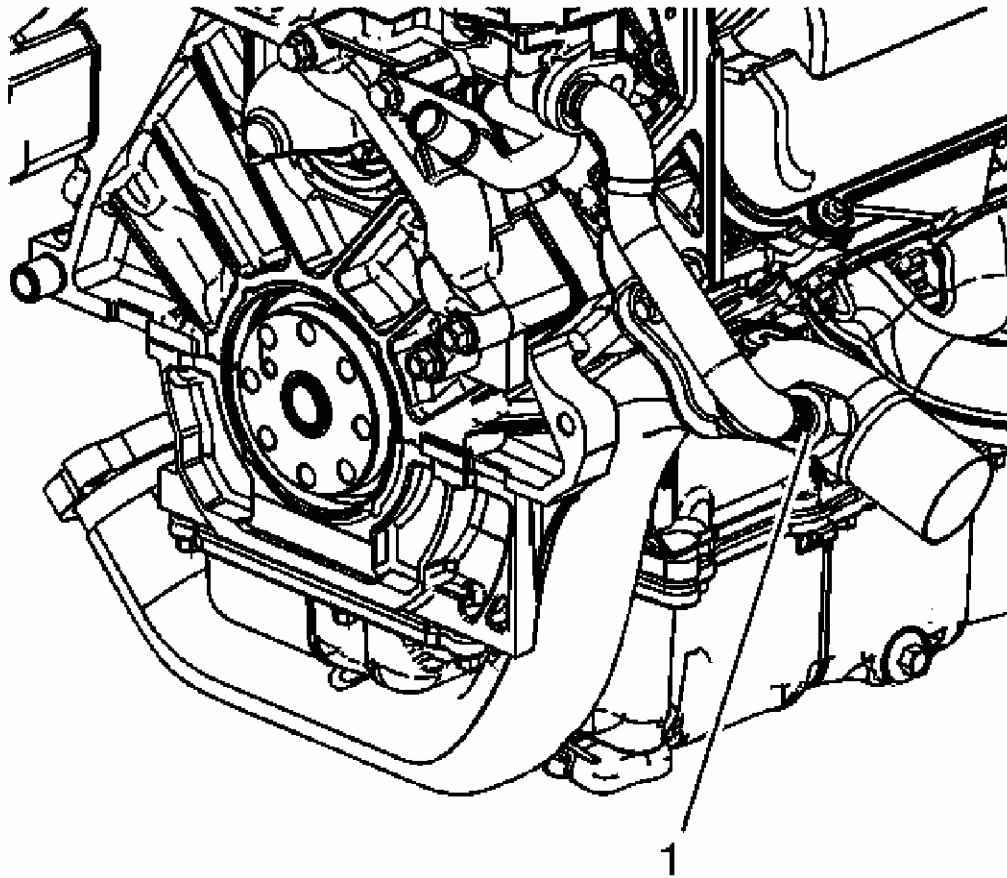


Fig. 206: Identifying EGR Valve Inlet Pipe Nut
Courtesy of GENERAL MOTORS CORP.

13. Disconnect the EGR valve inlet pipe nut (1) from the fitting on the exhaust intermediate pipe.

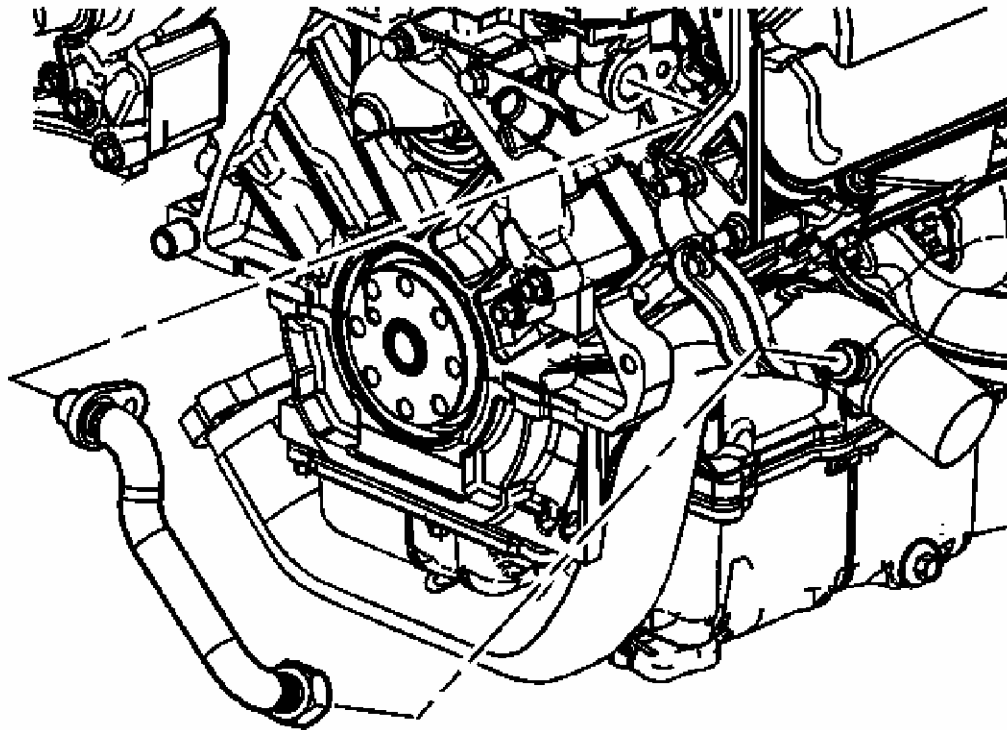


Fig. 207: Identifying EGR Valve Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

14. Remove and discard the EGR valve inlet pipe.

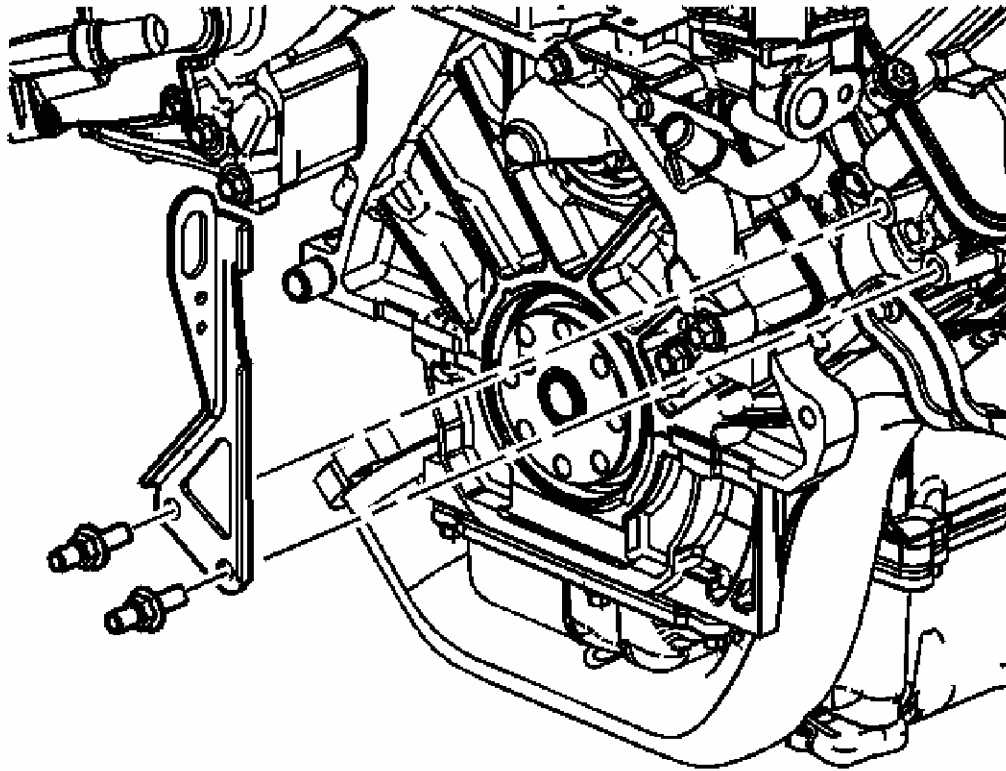


Fig. 208: Identifying Engine Rear Lift Bracket
Courtesy of GENERAL MOTORS CORP.

15. Remove the engine rear lift bracket bolts.
16. Remove the engine rear lift bracket.

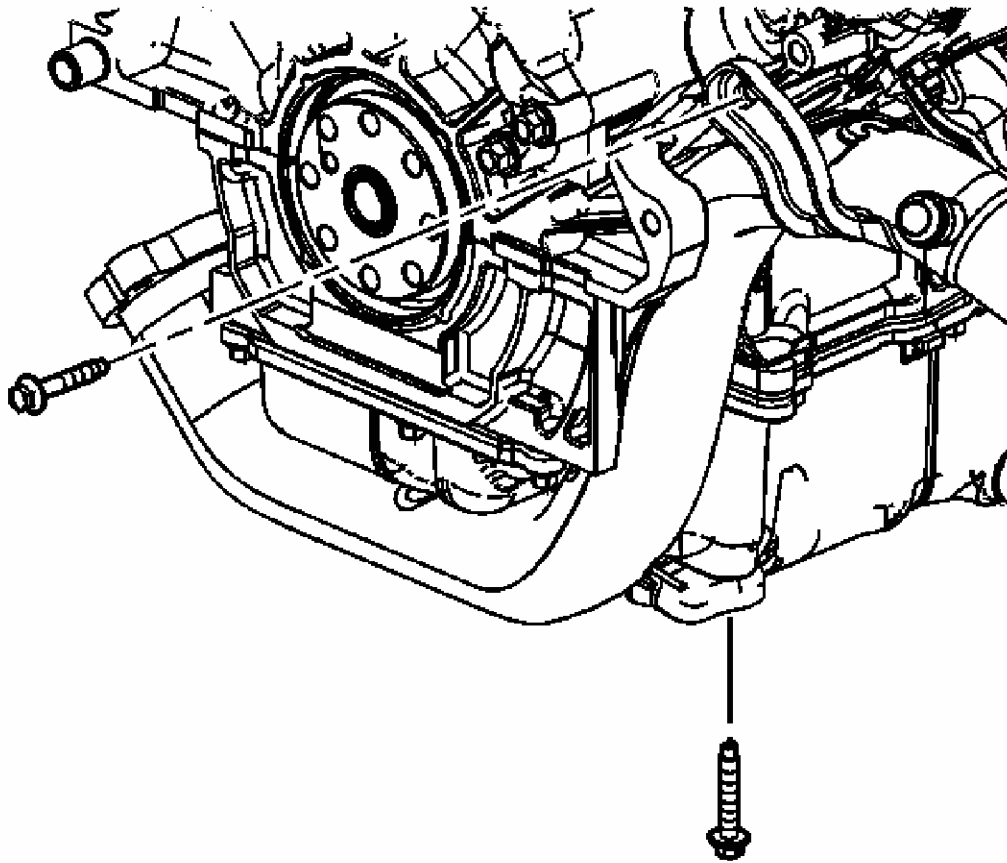


Fig. 209: View Of Exhaust Intermediate Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

17. Remove the exhaust intermediate pipe bolts.

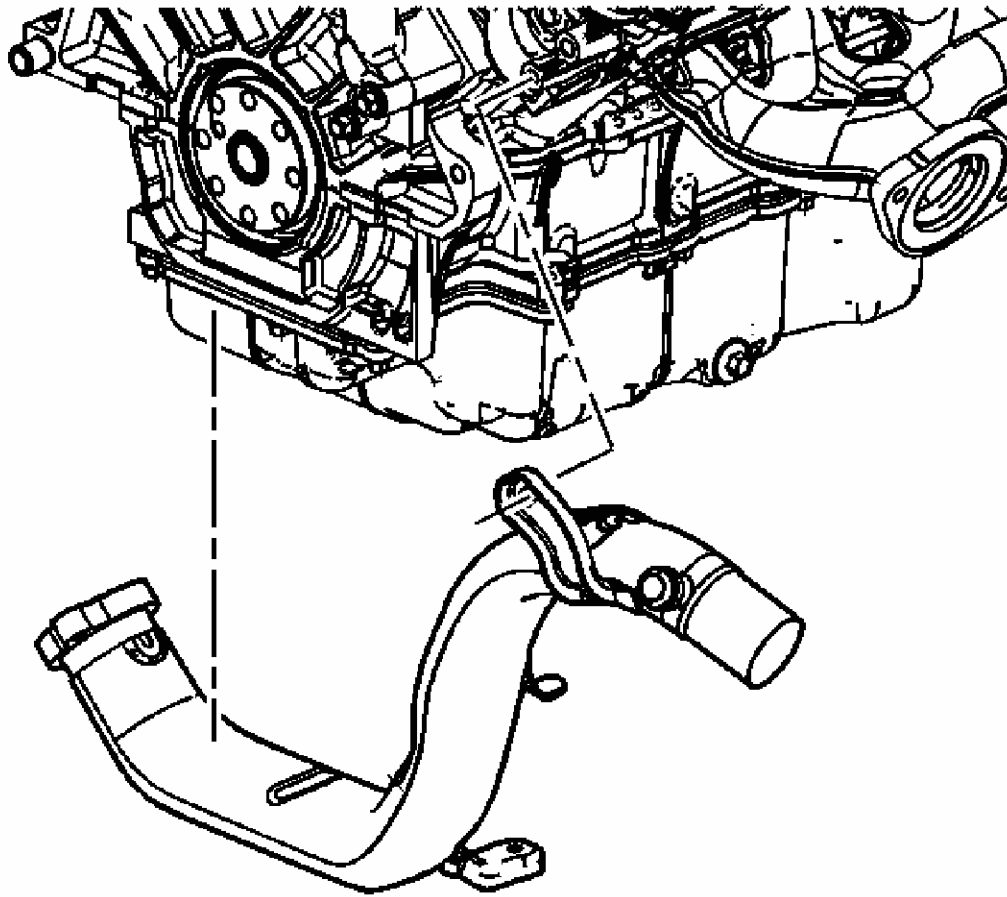


Fig. 210: Identifying Exhaust Intermediate Pipe
Courtesy of GENERAL MOTORS CORP.

18. Remove the exhaust intermediate pipe.

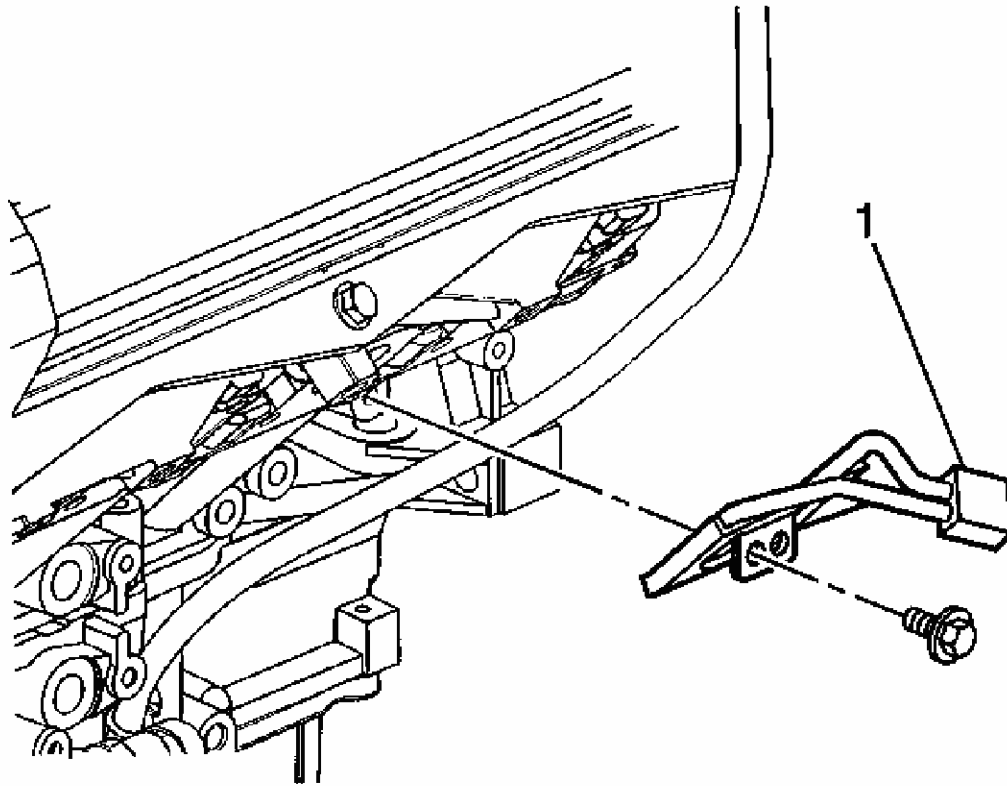


Fig. 211: Locating Left Side Coolant Heater
Courtesy of GENERAL MOTORS CORP.

19. If equipped, remove the left coolant heater (1) as follows:
1. Remove the coolant heater bolt.
 2. Remove the coolant heater from the cylinder block.

EXHAUST MANIFOLD REMOVAL - RIGHT SIDE (W/O RPO, NC1 OR NF7)

REMOVAL PROCEDURE

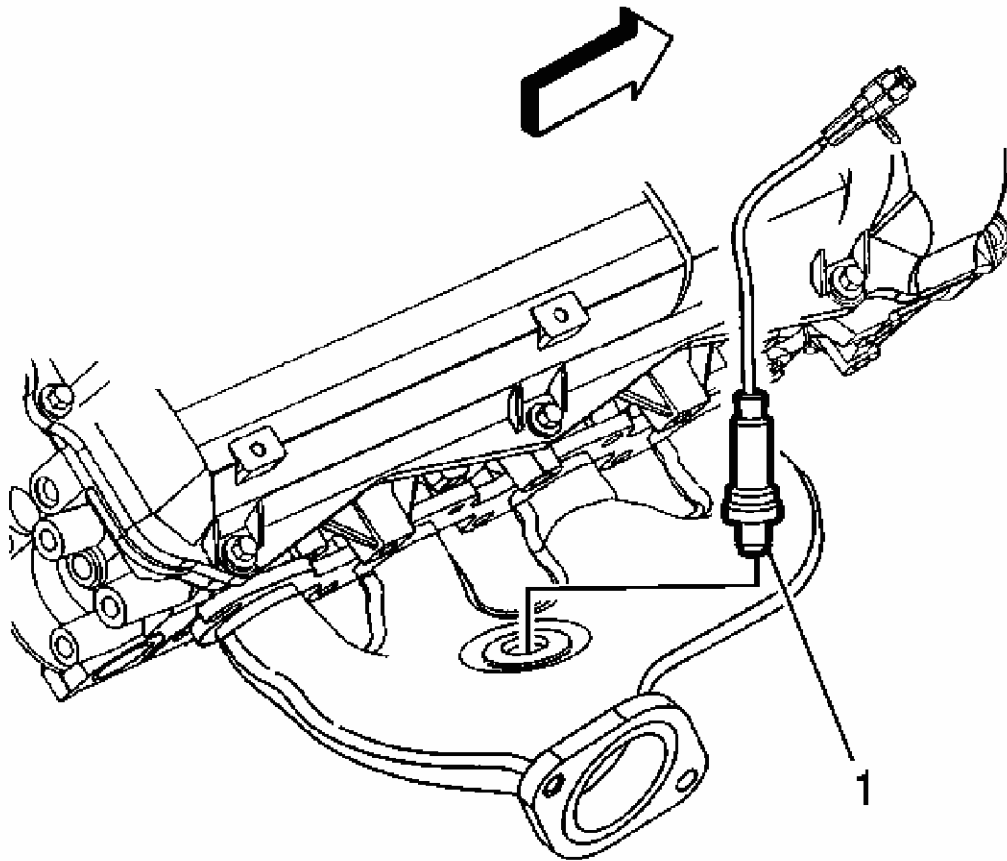


Fig. 212: View of Oxygen Sensor
Courtesy of GENERAL MOTORS CORP.

1. Remove the oxygen sensor (1) and inspect the sensor for excessive deposits or damage. Replace the oxygen sensor if necessary.

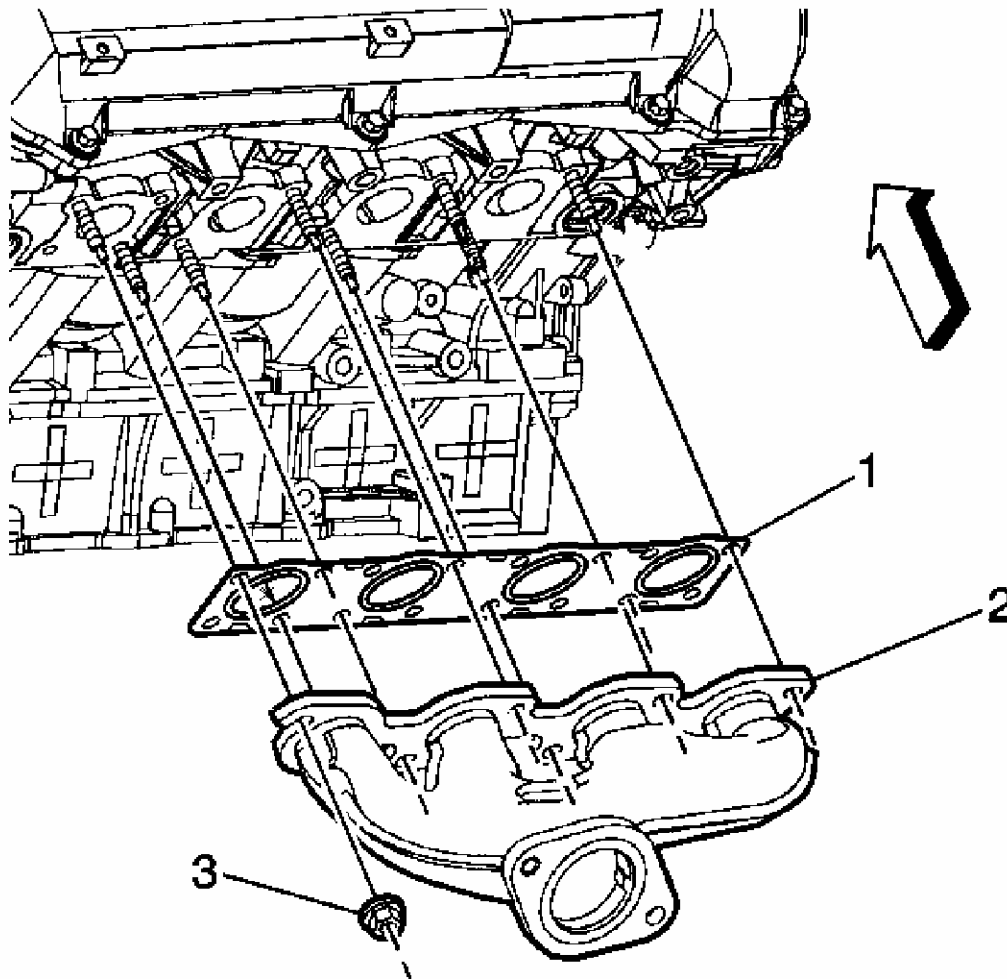


Fig. 213: Identifying Right Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: The stud must be reinstalled in the original location. The stud may remain attached to the nut when initially removed during exhaust manifold removal. In order to prevent exhaust leakage between the exhaust manifold and cylinder head the nut and stud combination must be reinstalled during exhaust manifold installation in the original location.

2. Remove the right exhaust manifold retaining nuts (3).

IMPORTANT: DO NOT reuse the exhaust manifold gasket.

3. Remove the exhaust manifold and the gasket (1).

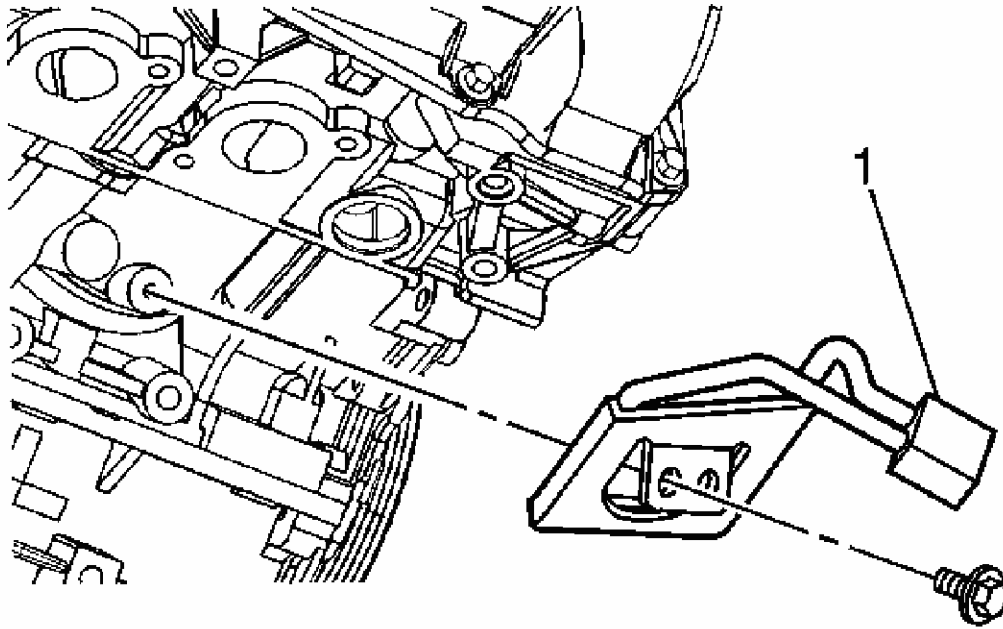


Fig. 214: Identifying Right Coolant Heater
Courtesy of GENERAL MOTORS CORP.

4. If equipped, remove the right coolant heater (1) as follows:
 1. Remove the coolant heater retaining bolt.
 2. Remove coolant heater from the cylinder block.

EXHAUST MANIFOLD REMOVAL - RIGHT SIDE (WITH RPO NC1 OR NF7)

REMOVAL PROCEDURE

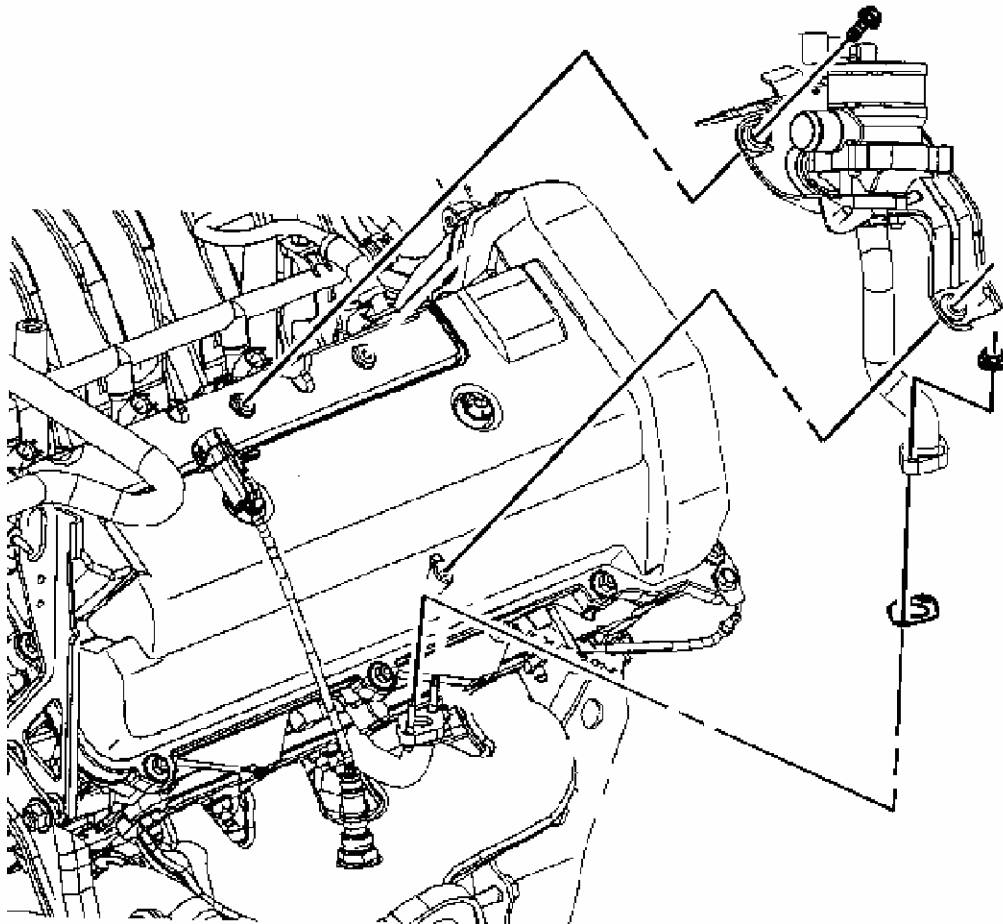


Fig. 215: Identifying Secondary Air Injection Valve Pipe Nuts
Courtesy of GENERAL MOTORS CORP.

1. Remove the secondary air injection (AIR) valve pipe nuts from the exhaust manifold.
2. Remove the AIR valve bolts from the mounting bracket.
3. Remove the AIR valve.

IMPORTANT: DO NOT reuse the AIR valve pipe gasket.

4. Remove and discard the AIR valve pipe gasket.

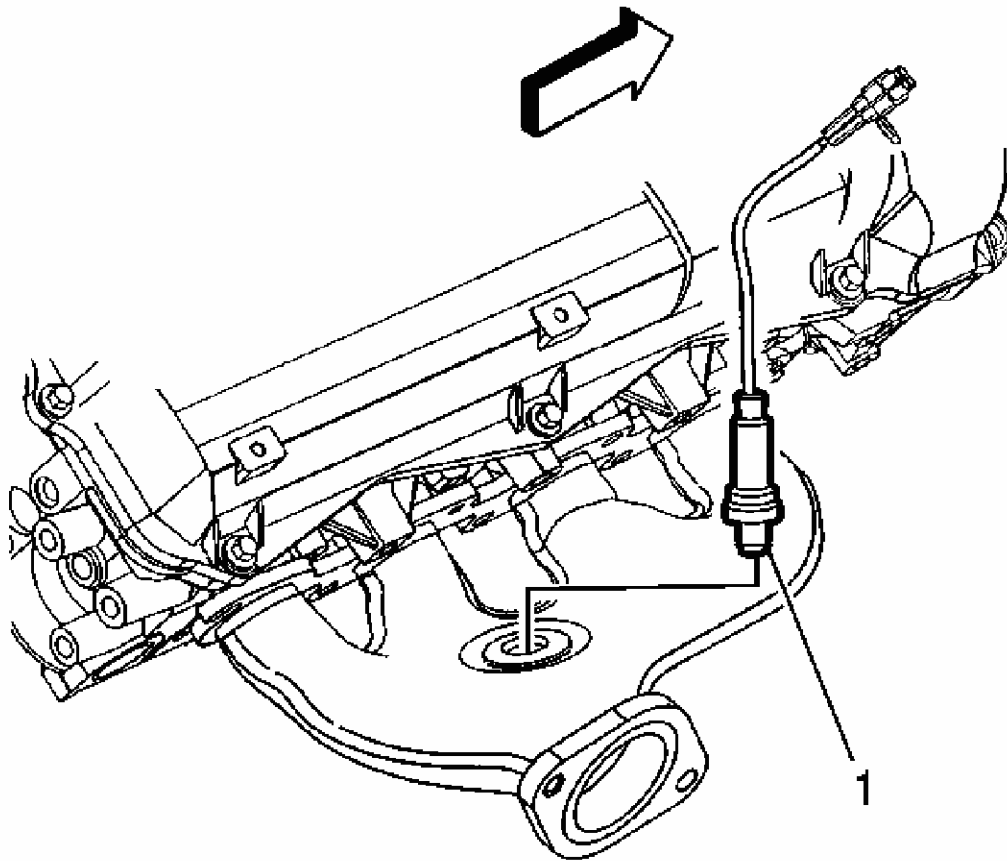


Fig. 216: View of Oxygen Sensor
Courtesy of GENERAL MOTORS CORP.

5. Remove the oxygen sensor (1) and inspect the sensor for excessive deposits or damage. Replace the oxygen sensor if necessary.

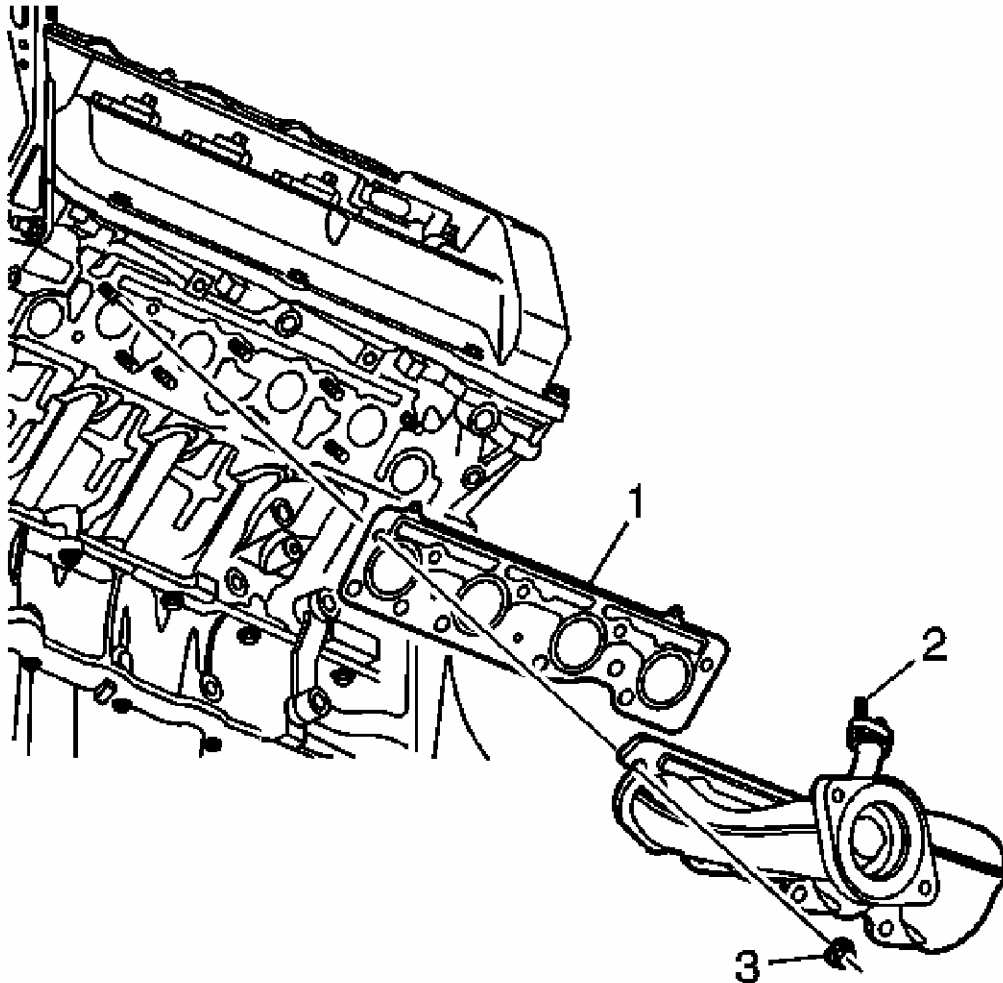


Fig. 217: Identifying Right Exhaust Manifold Retaining Nuts
Courtesy of GENERAL MOTORS CORP.

NOTE: The stud must be reinstalled in the original location. The stud may remain attached to the nut when initially removed during exhaust manifold removal. In order to prevent exhaust leakage between the exhaust manifold and cylinder head the nut and stud combination must be reinstalled during exhaust manifold installation in the original location.

6. Remove the right exhaust manifold retaining nuts (3).

IMPORTANT: DO NOT reuse the exhaust manifold gasket.

7. Remove the exhaust manifold and the gasket (1).

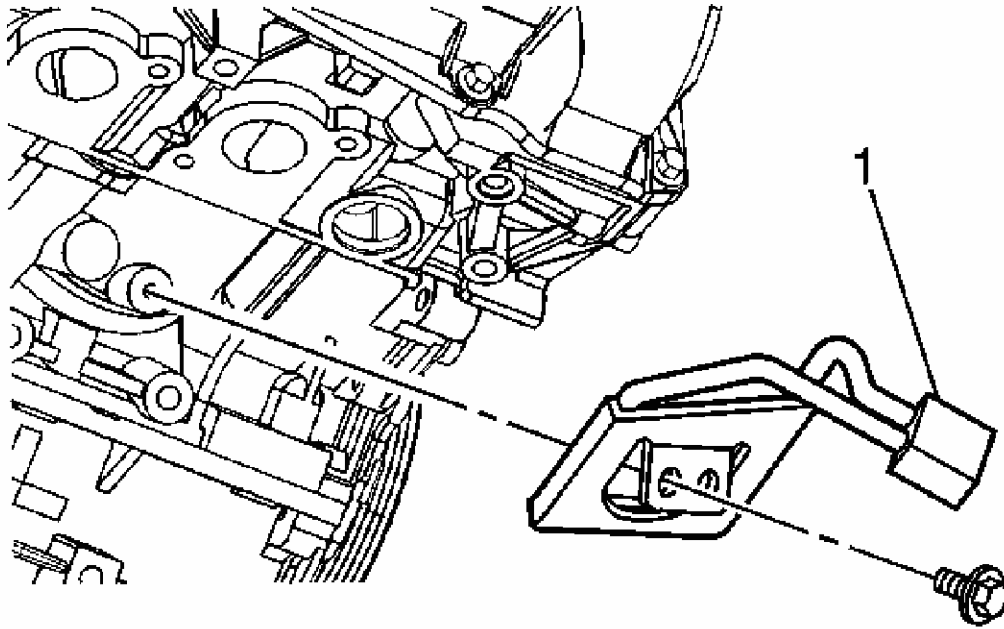


Fig. 218: Identifying Right Coolant Heater
Courtesy of GENERAL MOTORS CORP.

8. If equipped, remove the right coolant heater (1) as follows:
 1. Remove the coolant heater retaining bolt.
 2. Remove coolant heater from the cylinder block.

OIL FILTER ADAPTER REMOVAL (WITHOUT OIL COOLER)

REMOVAL PROCEDURE

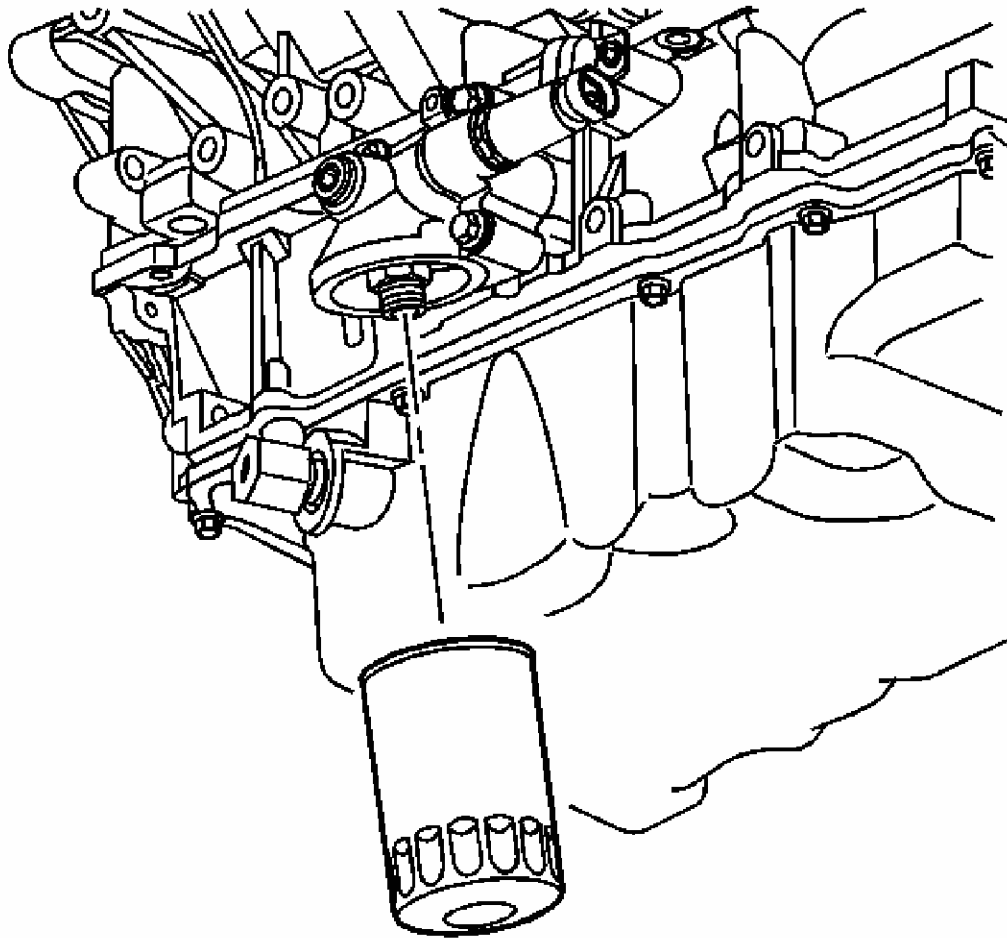


Fig. 219: View of Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter.

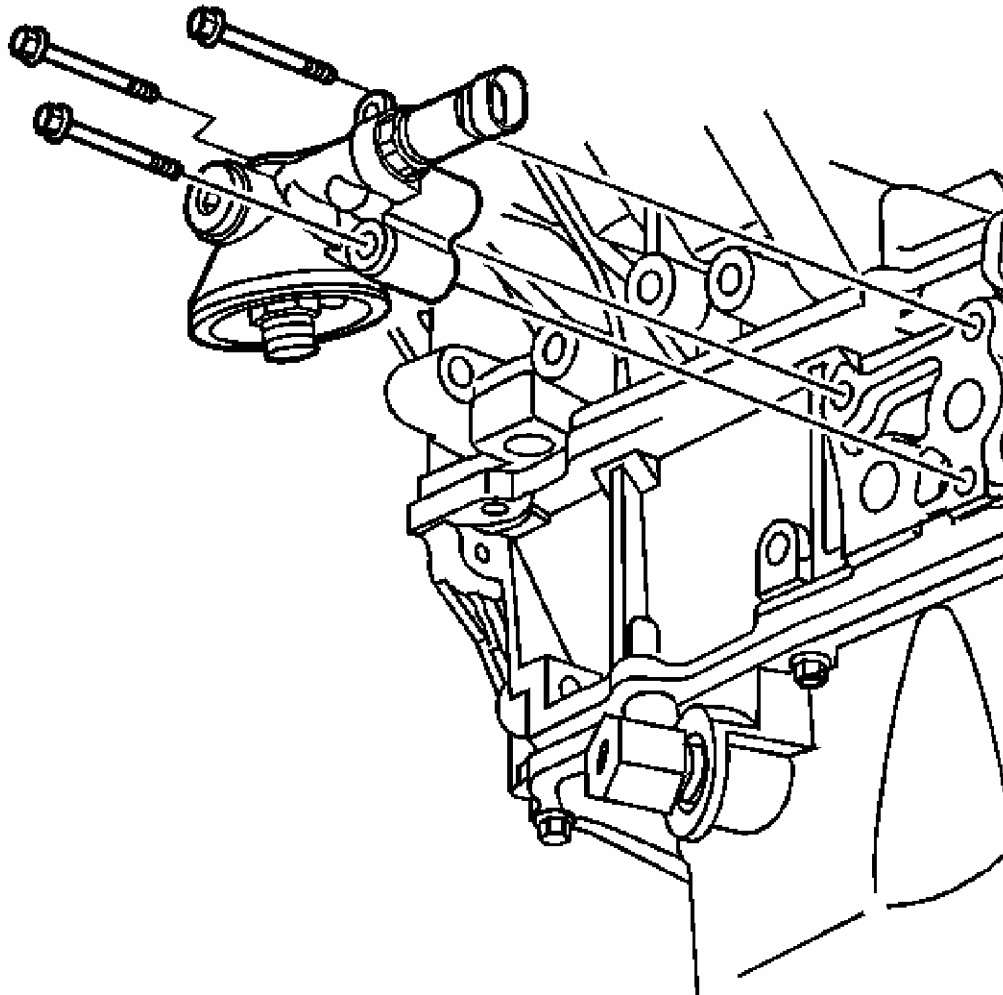


Fig. 220: Identifying Oil Filter Adapter Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil filter adapter mounting bolts.
3. Remove the oil filter adapter and discard the O-ring seals.
4. Remove the oil pressure switch, if necessary.

OIL FILTER ADAPTER REMOVAL (WITH OIL COOLER)

REMOVAL PROCEDURE

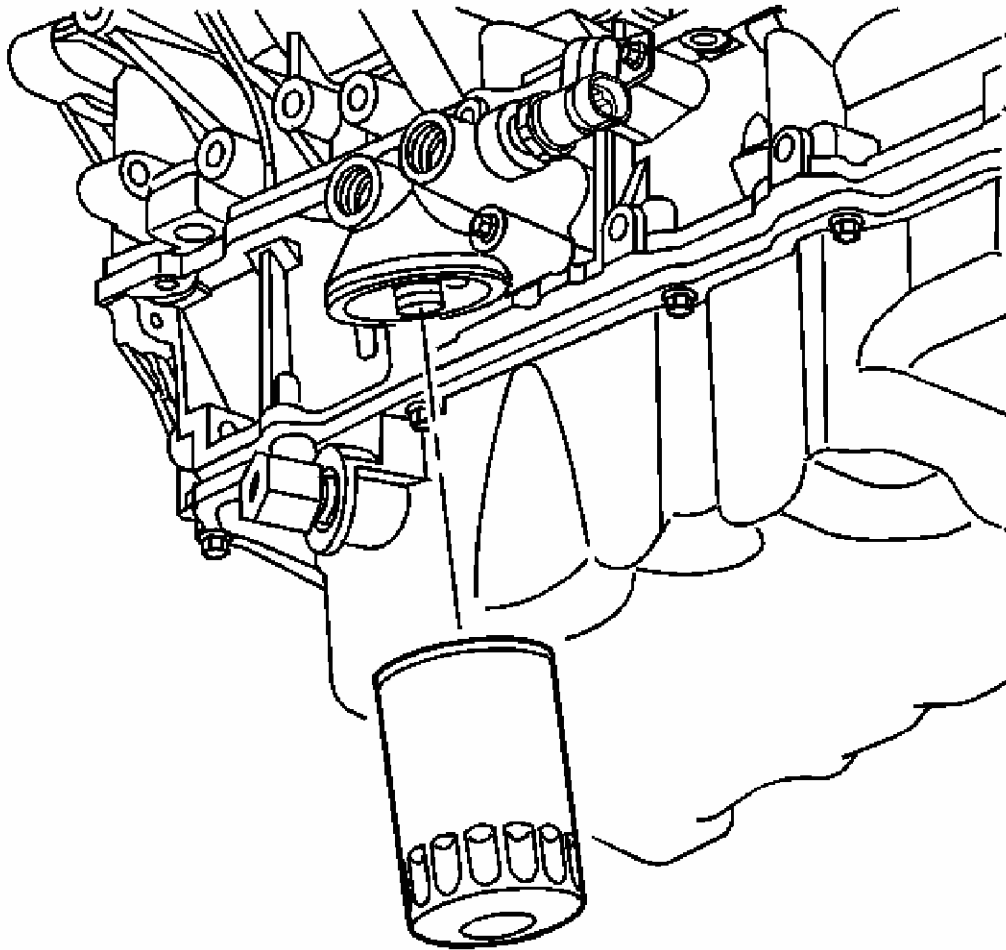


Fig. 221: View Of Oil Filter (with Oil Cooler)
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter.

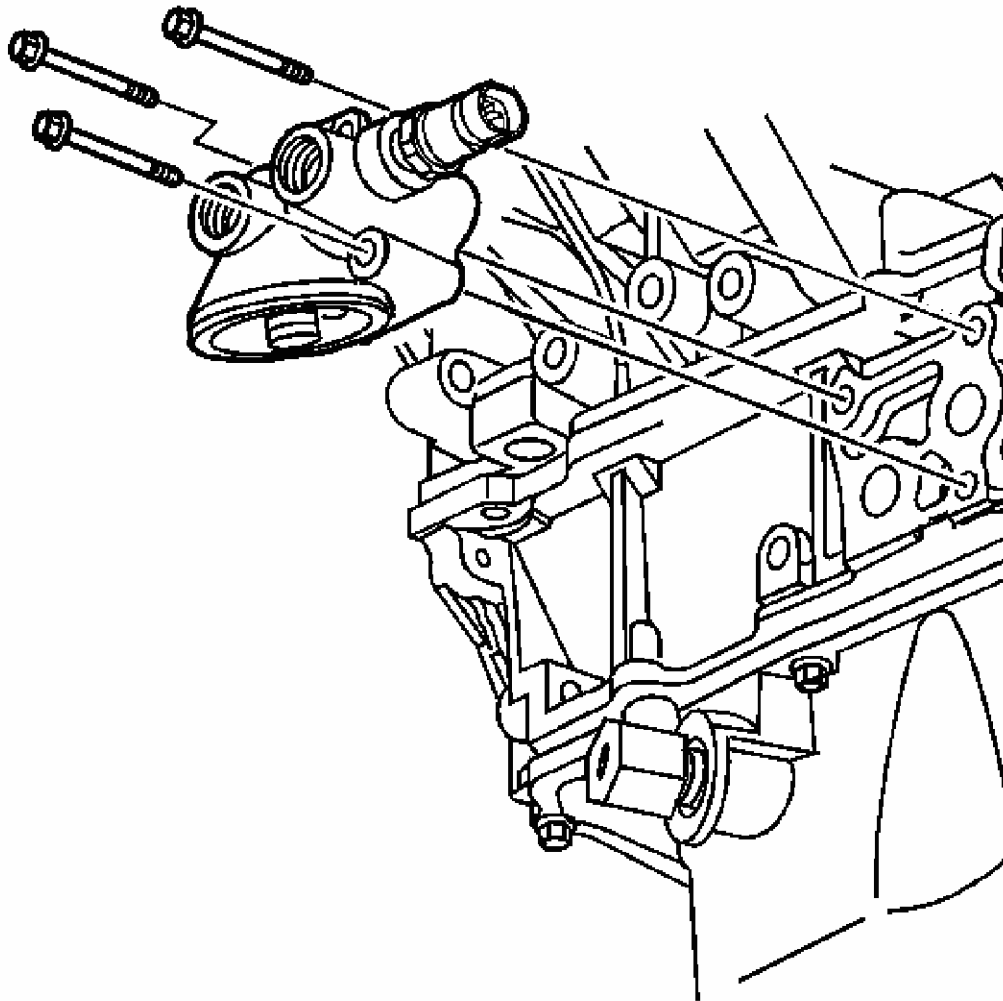


Fig. 222: Identifying Oil Filter Adapter Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil filter adapter mounting bolts.
3. Remove the oil filter adapter and discard the O-ring seals.
4. Remove the oil pressure switch, if necessary.

INTAKE MANIFOLD REMOVAL

REMOVAL PROCEDURE

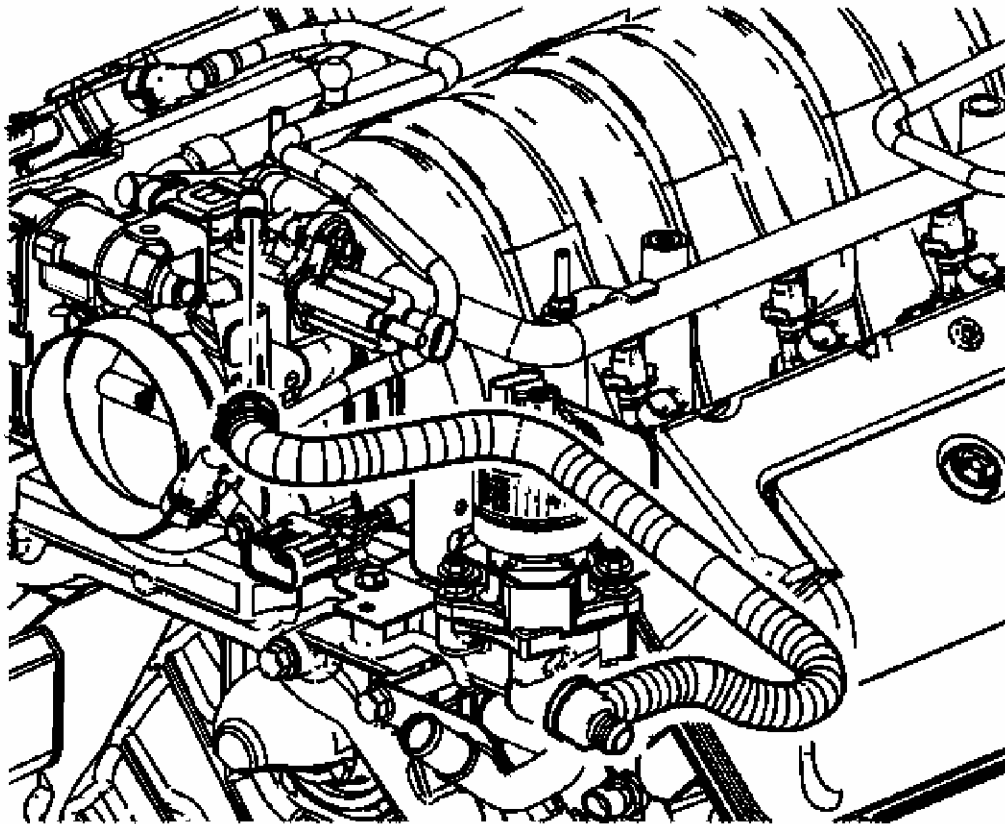


Fig. 223: Identifying Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

1. Remove the brake booster hose from the vacuum fitting in the water crossover.

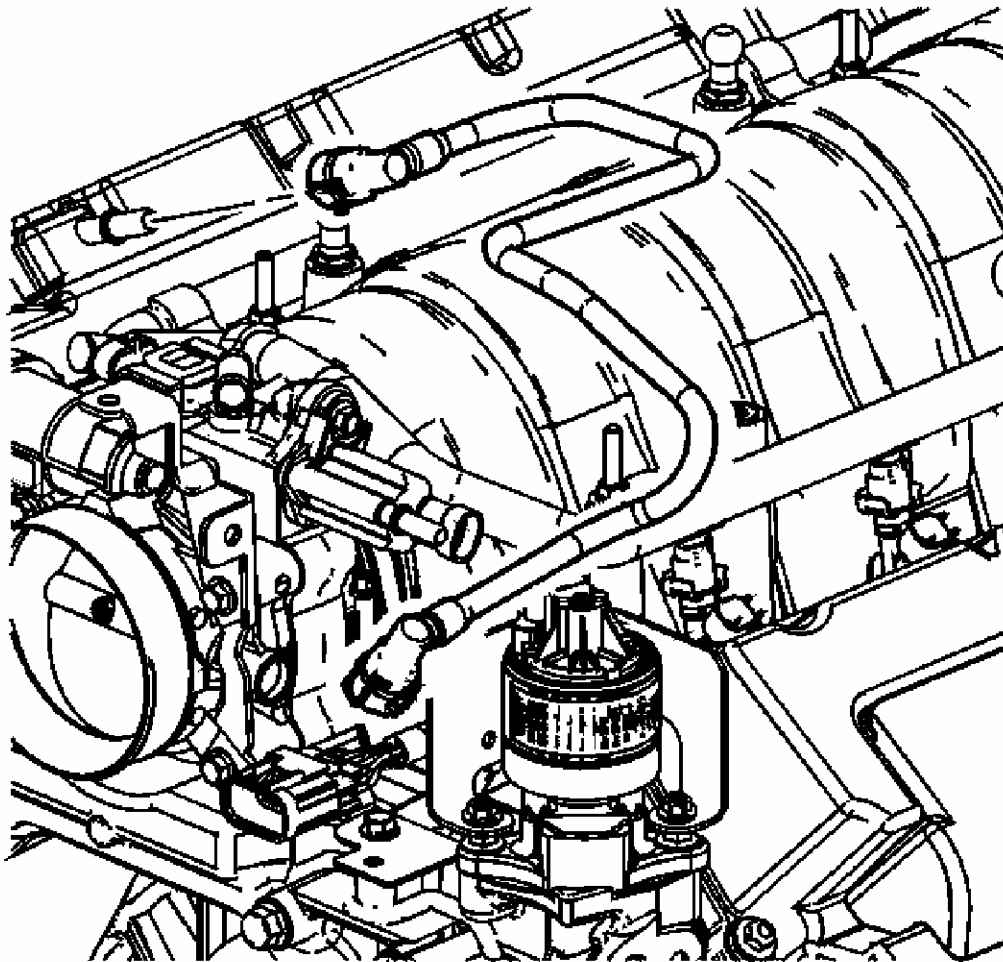


Fig. 224: Identifying PCV Fresh Air Feed Tube
Courtesy of GENERAL MOTORS CORP.

2. Remove the PCV fresh air feed tube from the camshaft cover and the throttle body.

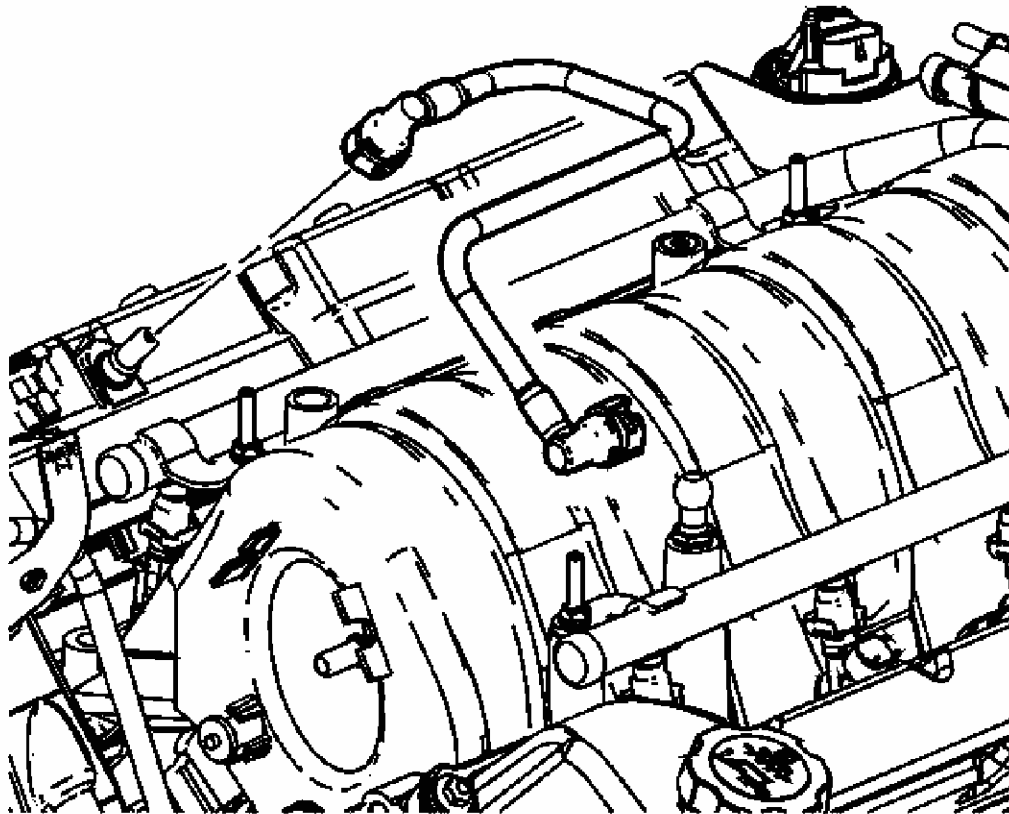


Fig. 225: Identifying PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

3. Remove the PCV dirty air tube from the PCV orifice in the right camshaft cover and from the intake manifold.

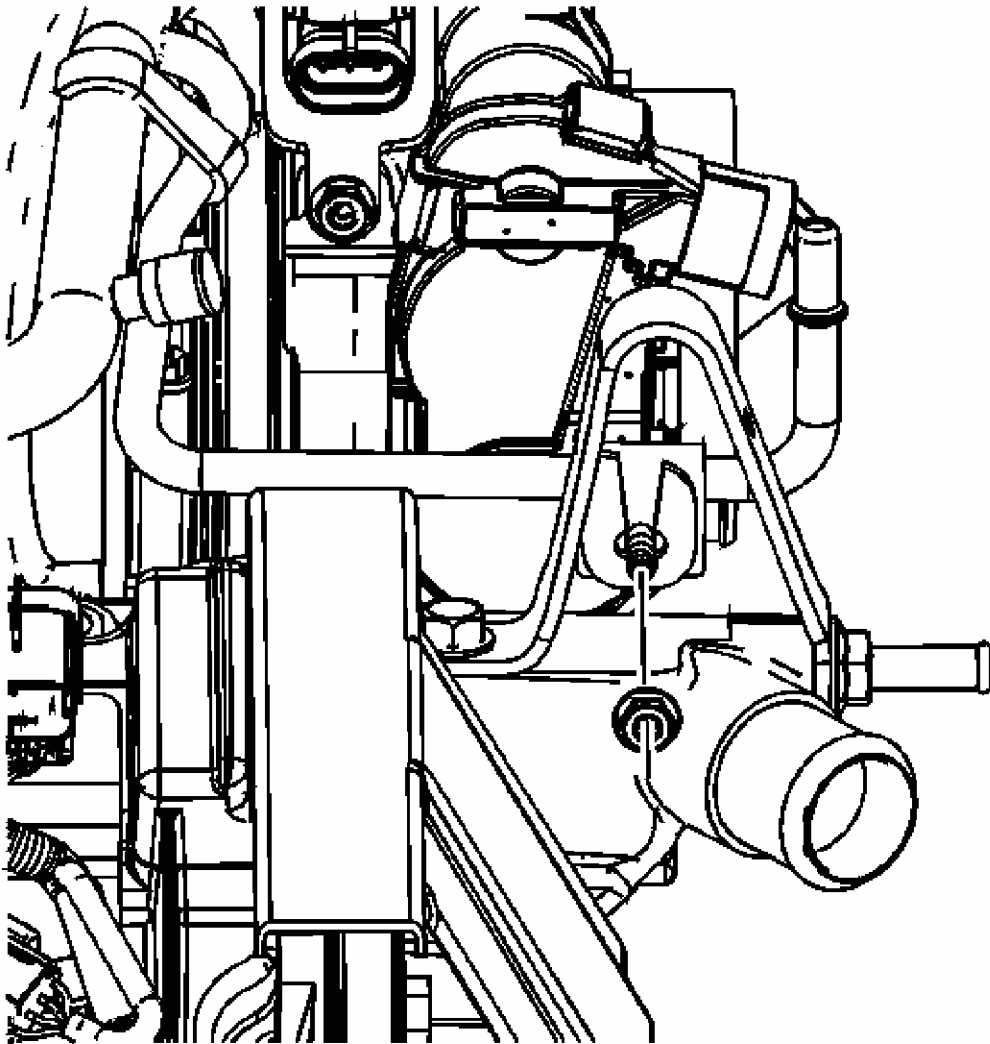


Fig. 226: Identifying Fuel Rail Bracket
Courtesy of GENERAL MOTORS CORP.

4. Remove the fuel rail bracket nut from the fuel rail stud mounted to the engine lift bracket on the water crossover.

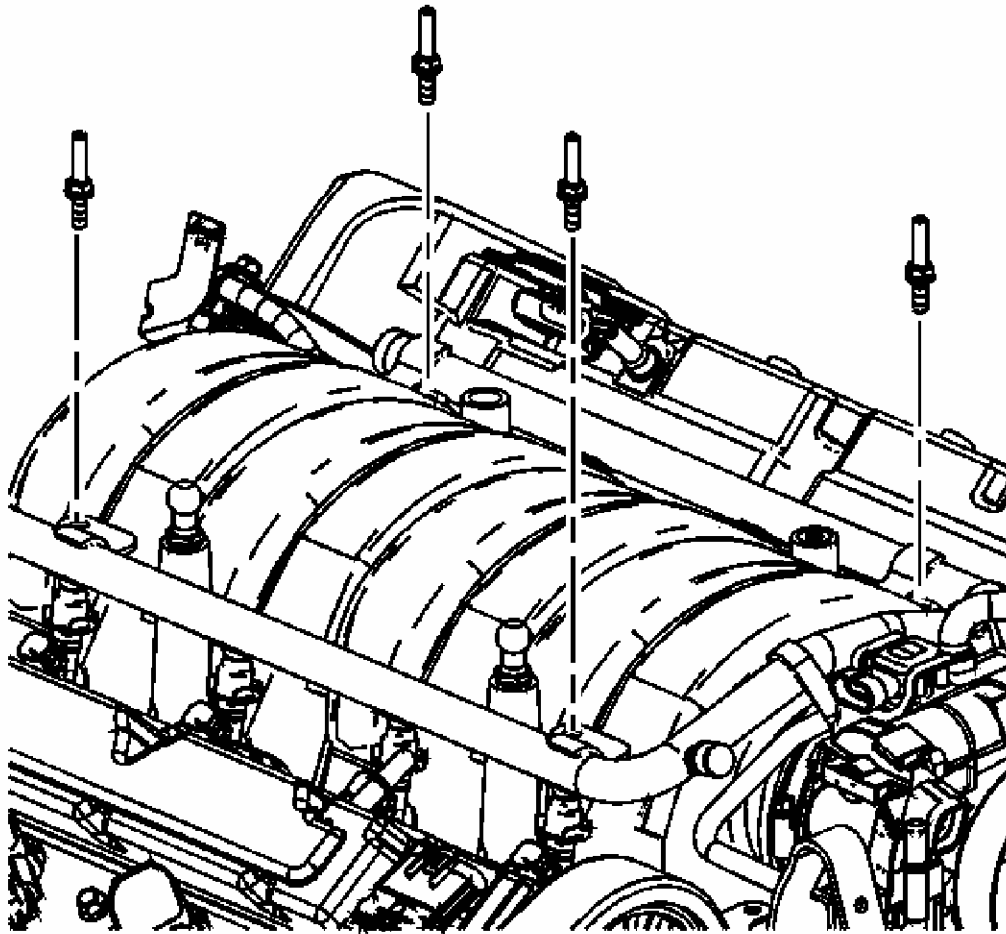


Fig. 227: Identifying Fuel Rail Studs
Courtesy of GENERAL MOTORS CORP.

5. Remove the fuel rail studs.

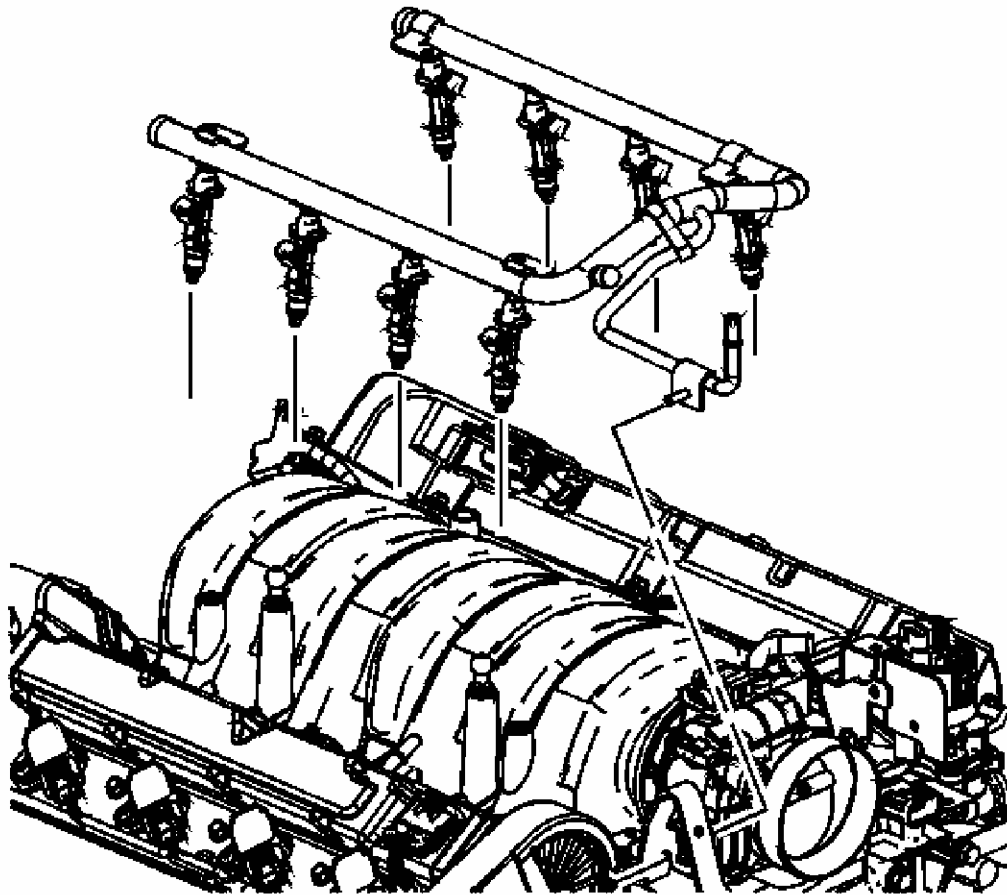


Fig. 228: Identifying Fuel Injectors & Fuel Rail
Courtesy of GENERAL MOTORS CORP.

6. Lift and remove the fuel rail with injectors.

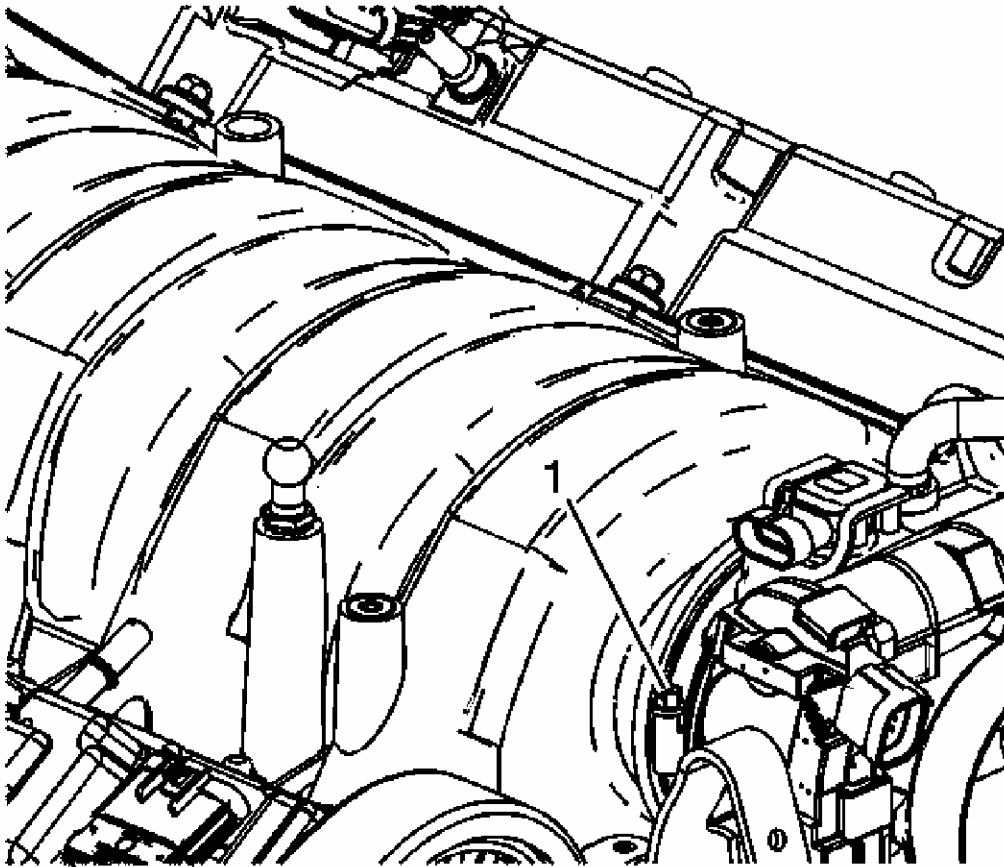


Fig. 229: Locating Plenum Duct Clamp
Courtesy of GENERAL MOTORS CORP.

7. Loosen the plenum duct clamp (1) in order to remove the intake manifold.

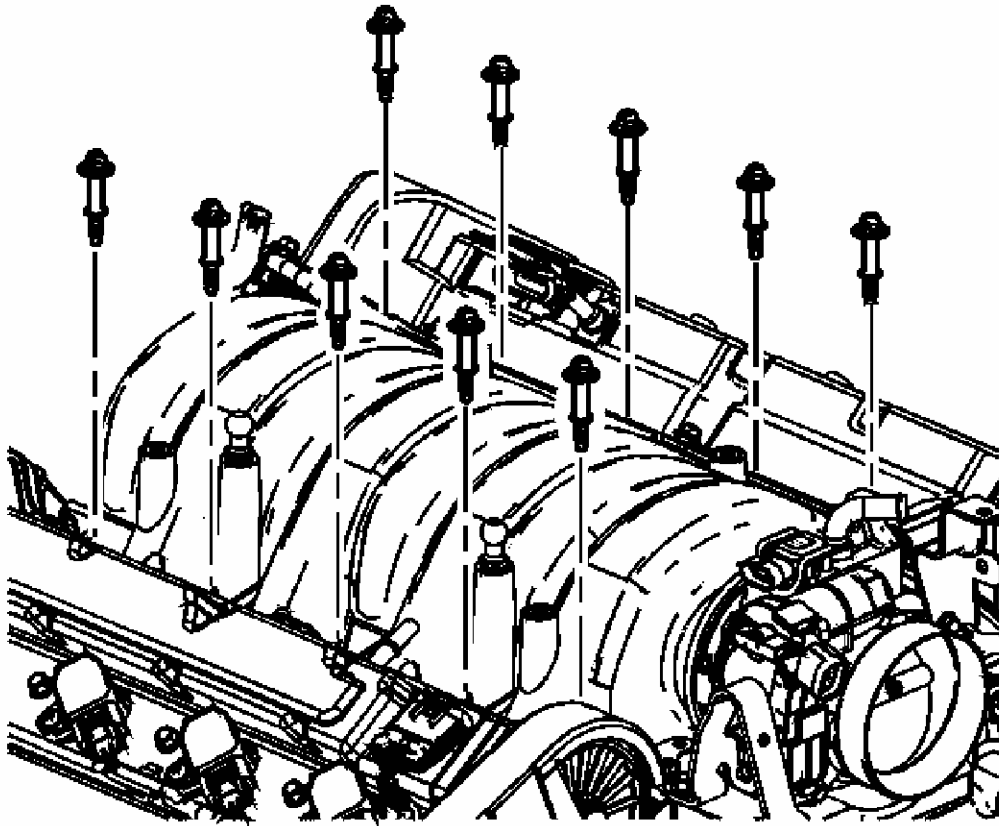


Fig. 230: Identifying Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the intake manifold bolts.

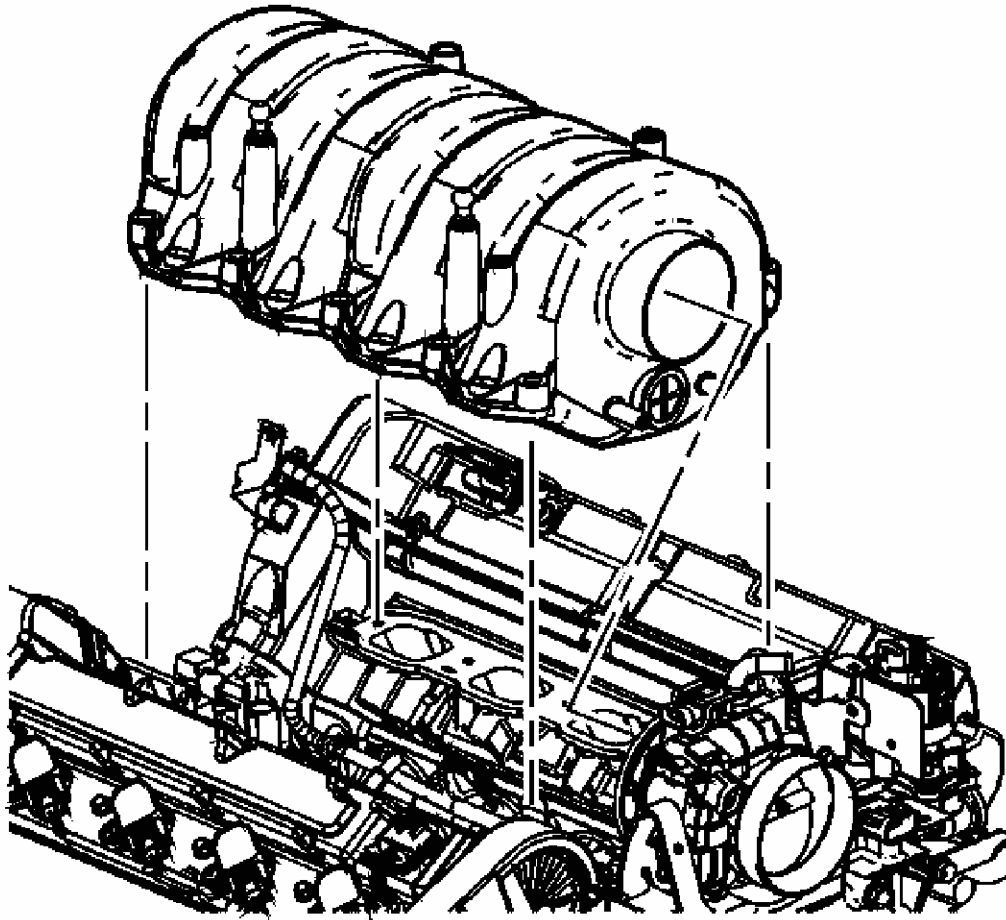


Fig. 231: View Of Intake Manifold
Courtesy of GENERAL MOTORS CORP.

9. Remove the intake manifold.

WATER CROSSOVER REMOVAL

REMOVAL PROCEDURE

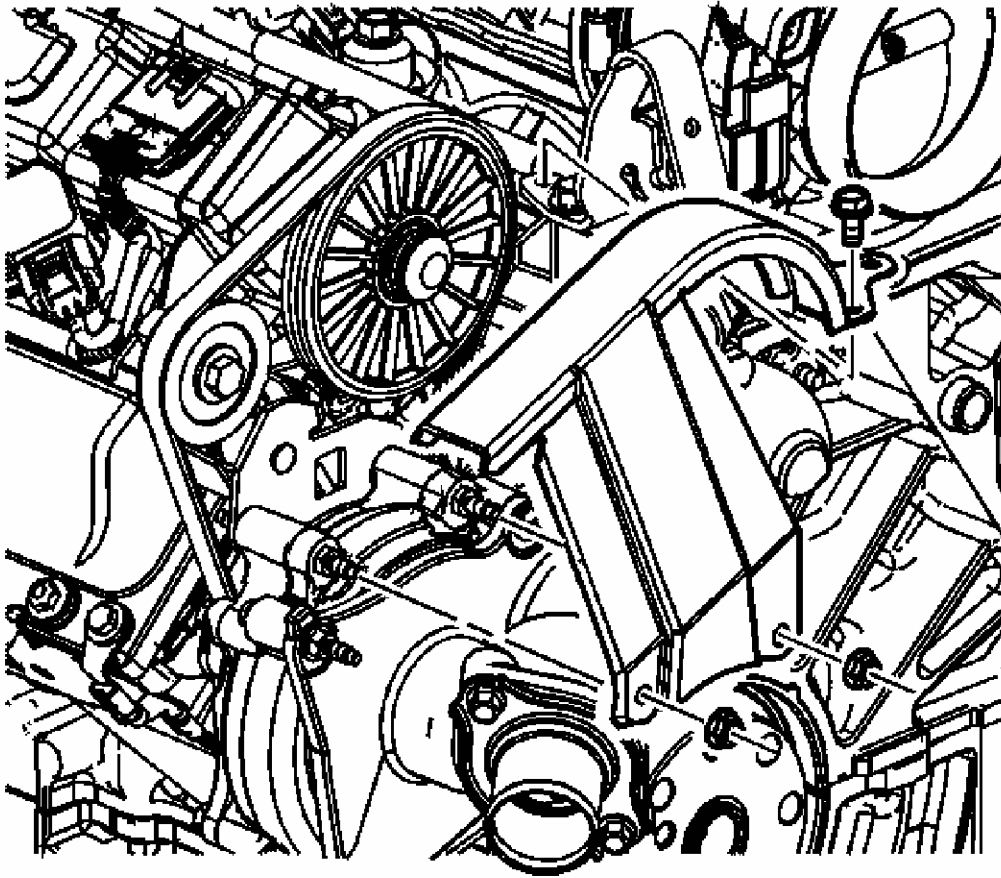


Fig. 232: Identifying Water Pump Drive Belt Shield Bolt & Nuts
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump drive belt shield bolt and nuts.
2. Remove the water pump drive belt shield.

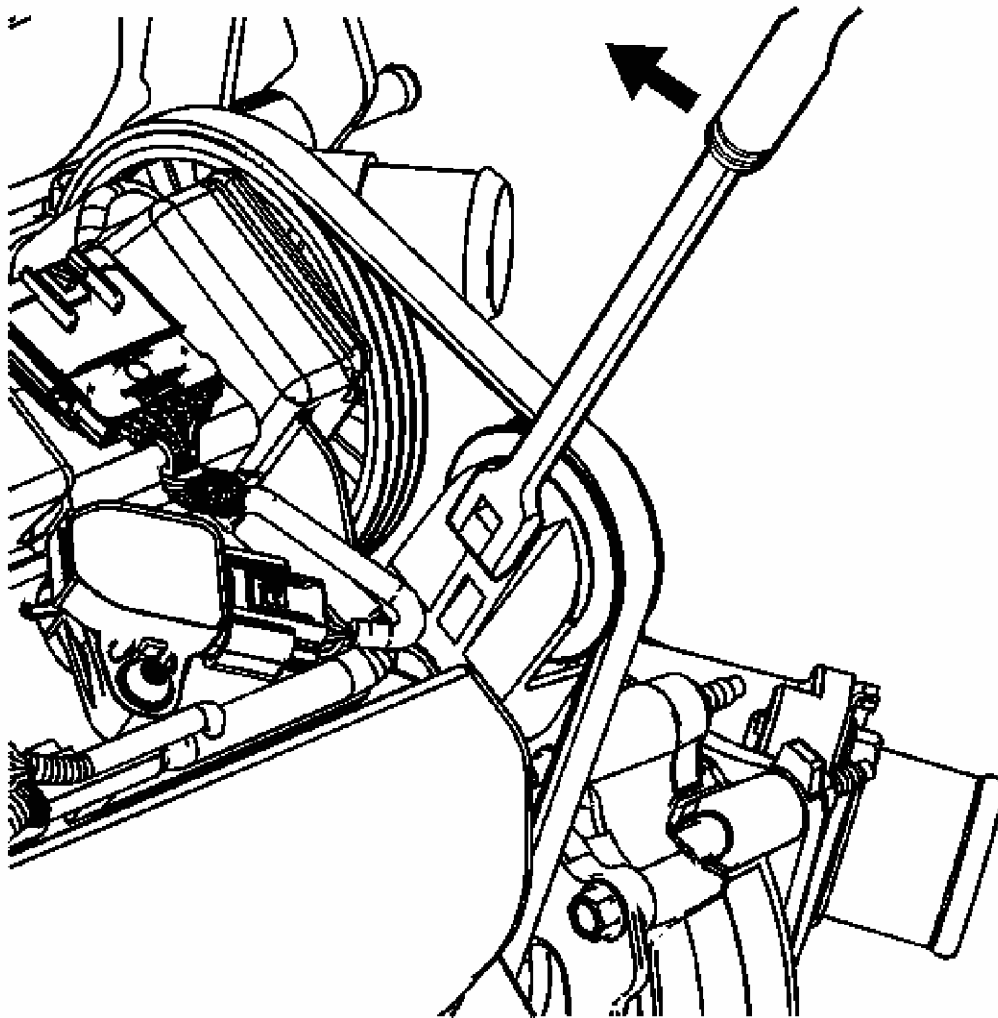


Fig. 233: Rotating Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

3. Remove the water pump drive belt by compressing the belt tensioner while sliding the belt off the drive pulley and the water pump pulley.

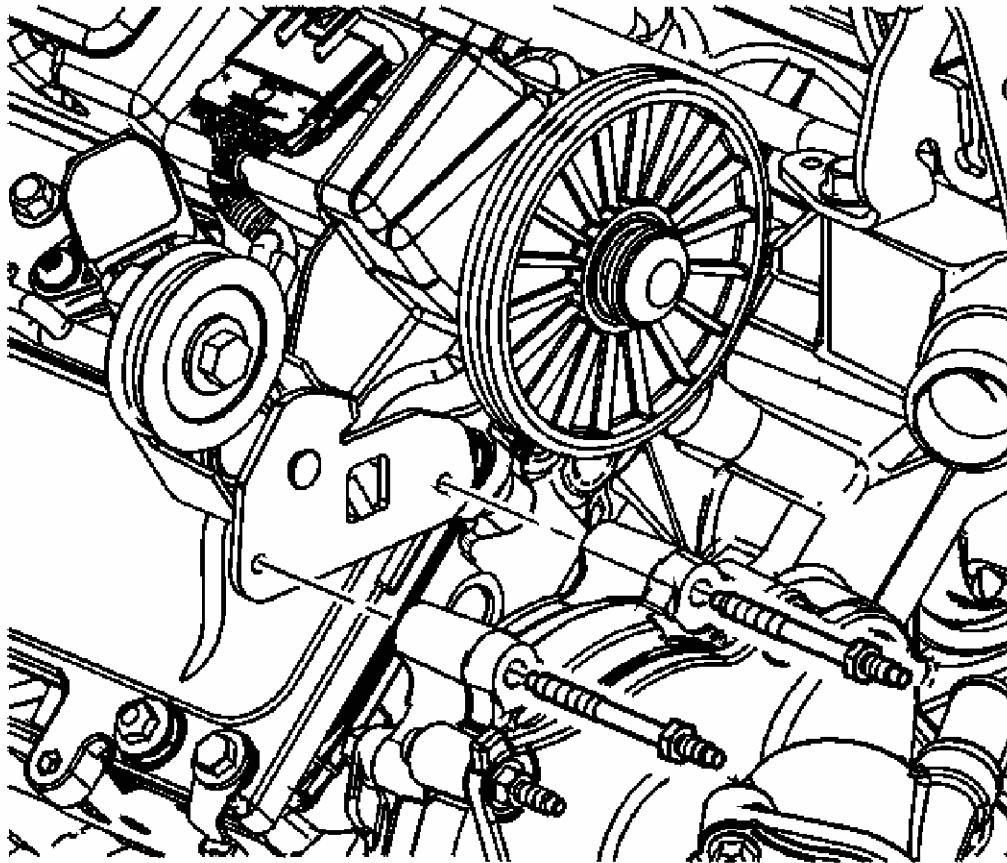


Fig. 234: Identifying Water Pump Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

4. Remove the water pump drive belt tensioner bolts from the tensioner.
5. Remove the water pump drive belt tensioner from the water crossover.

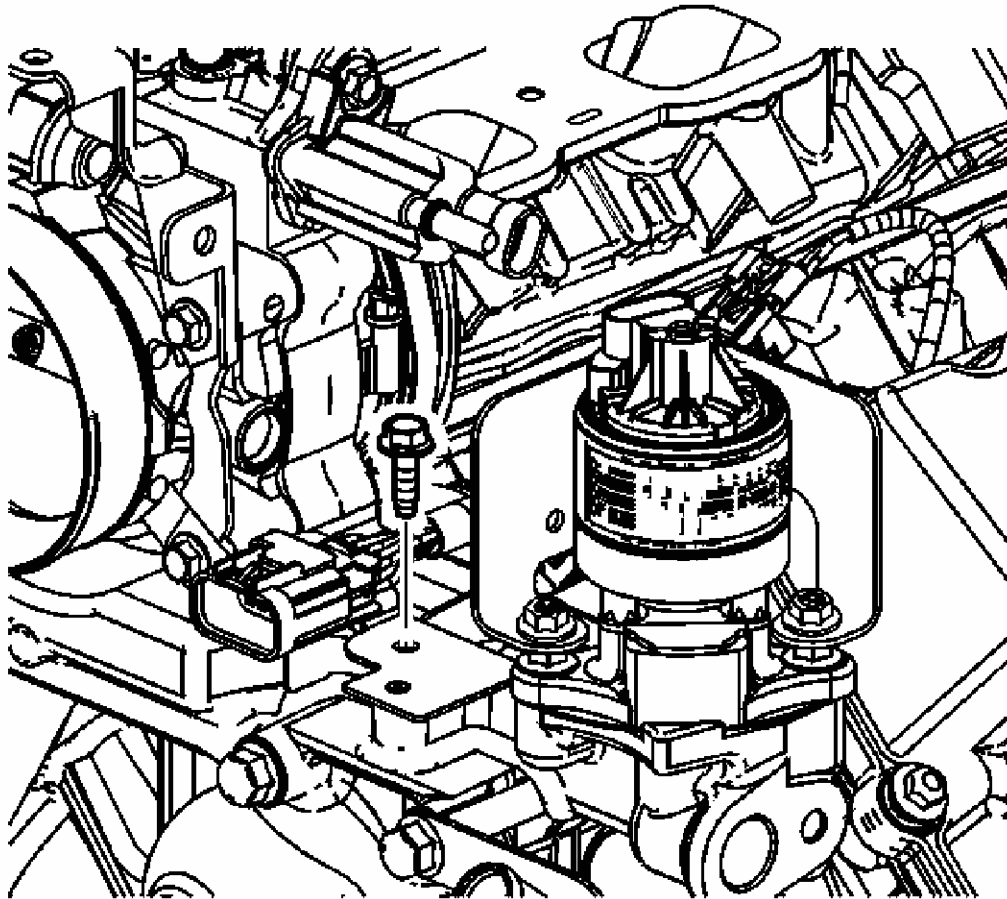


Fig. 235: Identifying Crankshaft Position Sensor & Knock Sensor Wiring Harness Bracket Bolt

Courtesy of GENERAL MOTORS CORP.

6. Remove the crankshaft position sensor and knock sensor wiring harness bracket bolt.

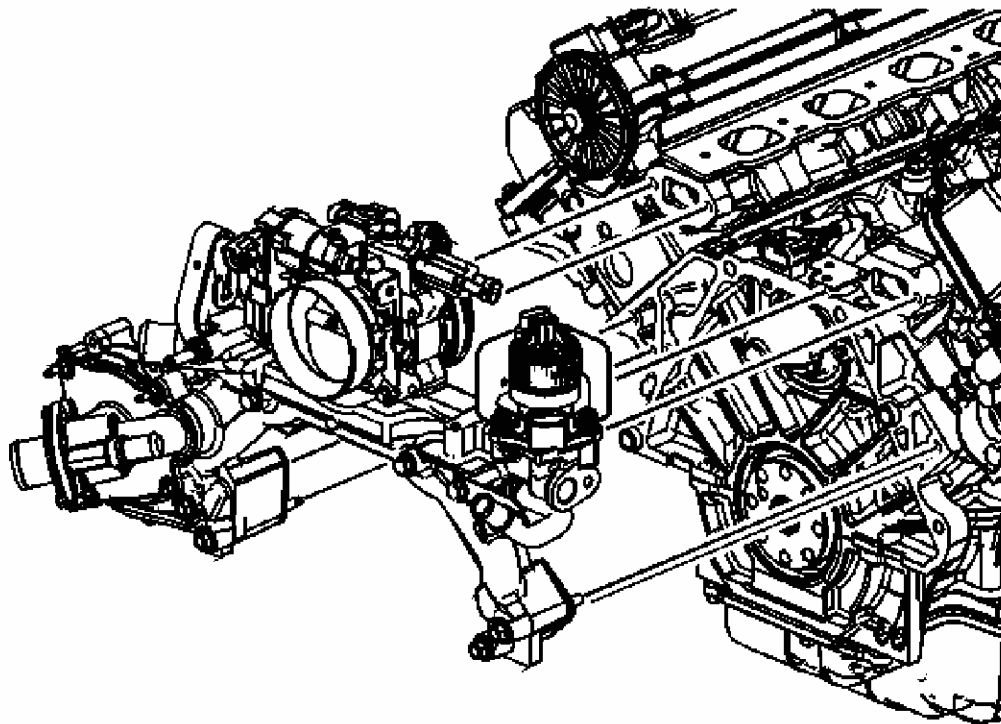


Fig. 236: View Of Water Pump Housing
Courtesy of GENERAL MOTORS CORP.

7. Loosen the water crossover mounting bolts.
8. Remove the water crossover and all mounting bolts.

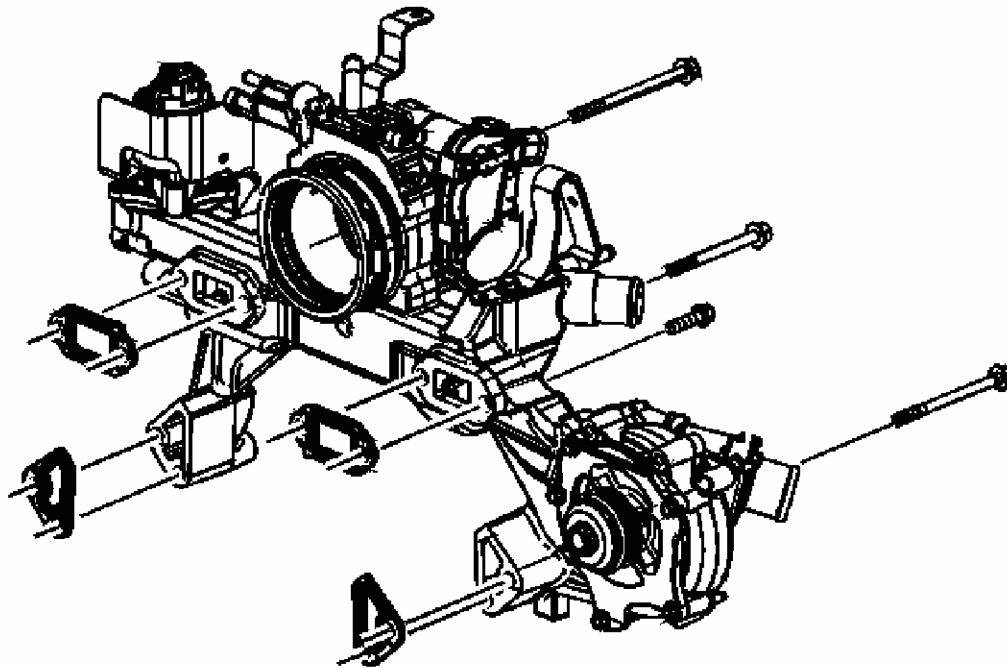


Fig. 237: View Of Water Pump Housing Gaskets & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the water crossover gaskets and mounting bolts from the water crossover.

STARTER REMOVAL

REMOVAL PROCEDURE

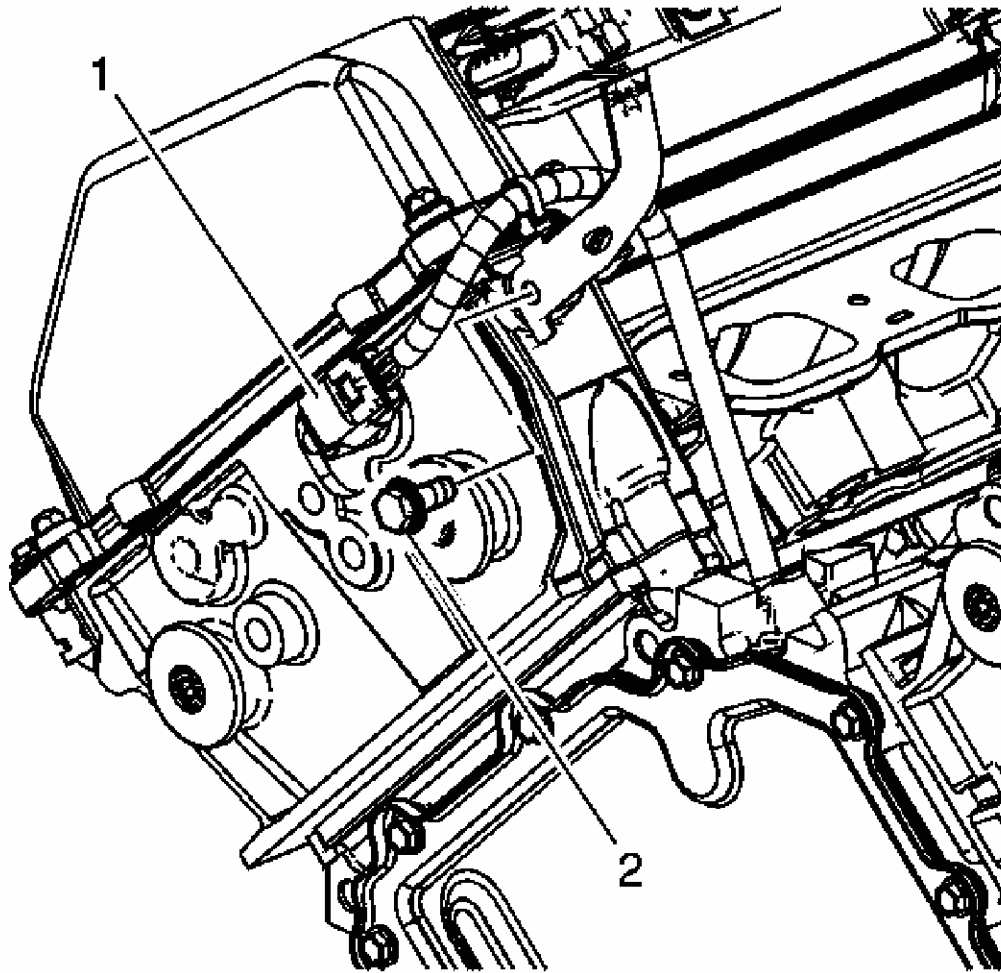


Fig. 238: Identifying Crankshaft Position Sensor & Wiring Harness
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the crankshaft position sensor wiring harness (1) from the camshaft position (CMP) sensor.
2. Remove the jumping ground bracket bolt (2) from the right cylinder head.

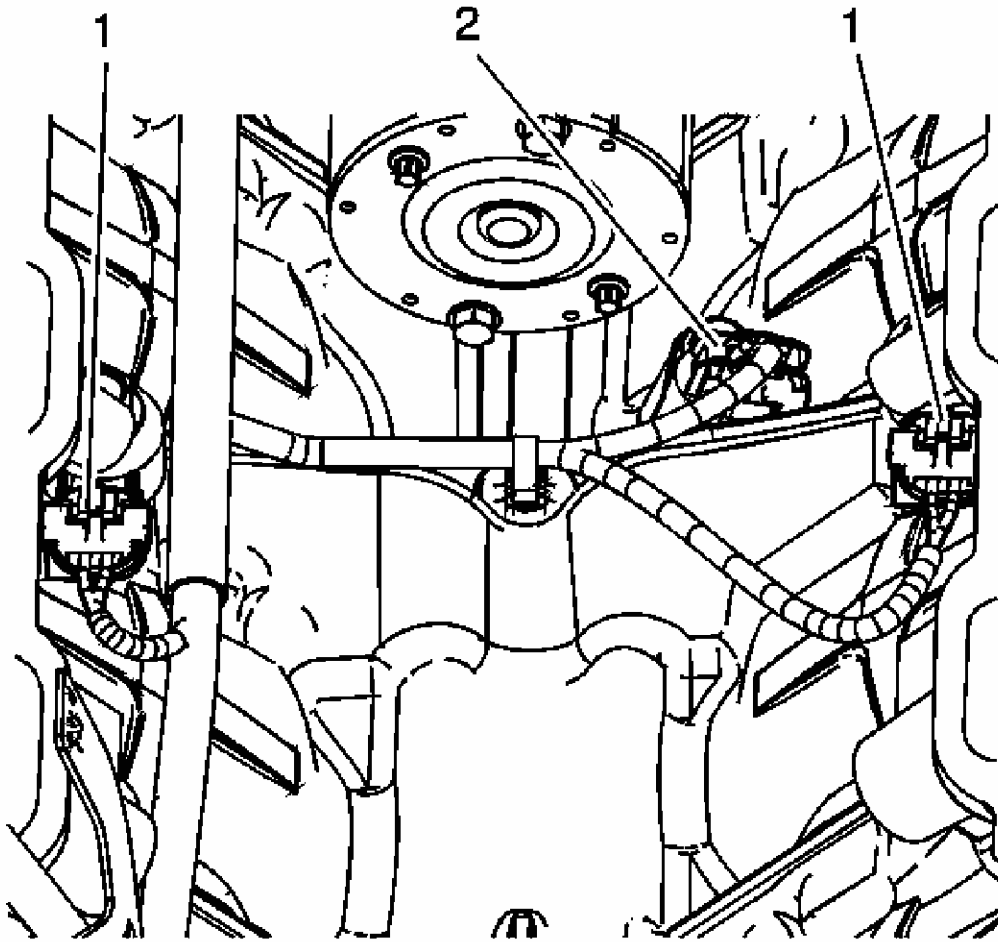


Fig. 239: View Of CKP & KS Sensor Wiring Harness

Courtesy of GENERAL MOTORS CORP.

3. Disconnect the crankshaft position sensor wiring harness (1) from the knock (KS) sensors.
4. Disconnect the crankshaft position sensor wiring harness (2) from the crankshaft position (CKP) sensor.

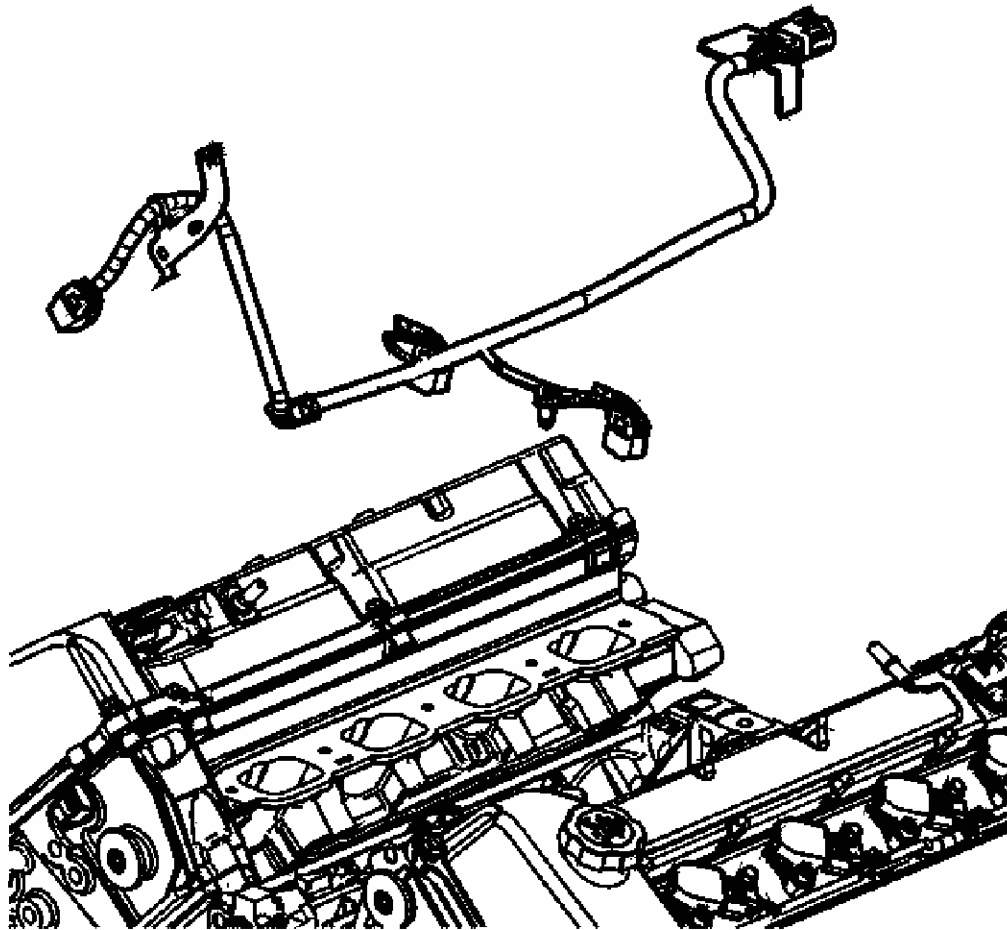


Fig. 240: Identifying Crankshaft Position Sensor Wiring Harness
Courtesy of GENERAL MOTORS CORP.

5. Remove the crankshaft position sensor wiring harness from the engine valley.

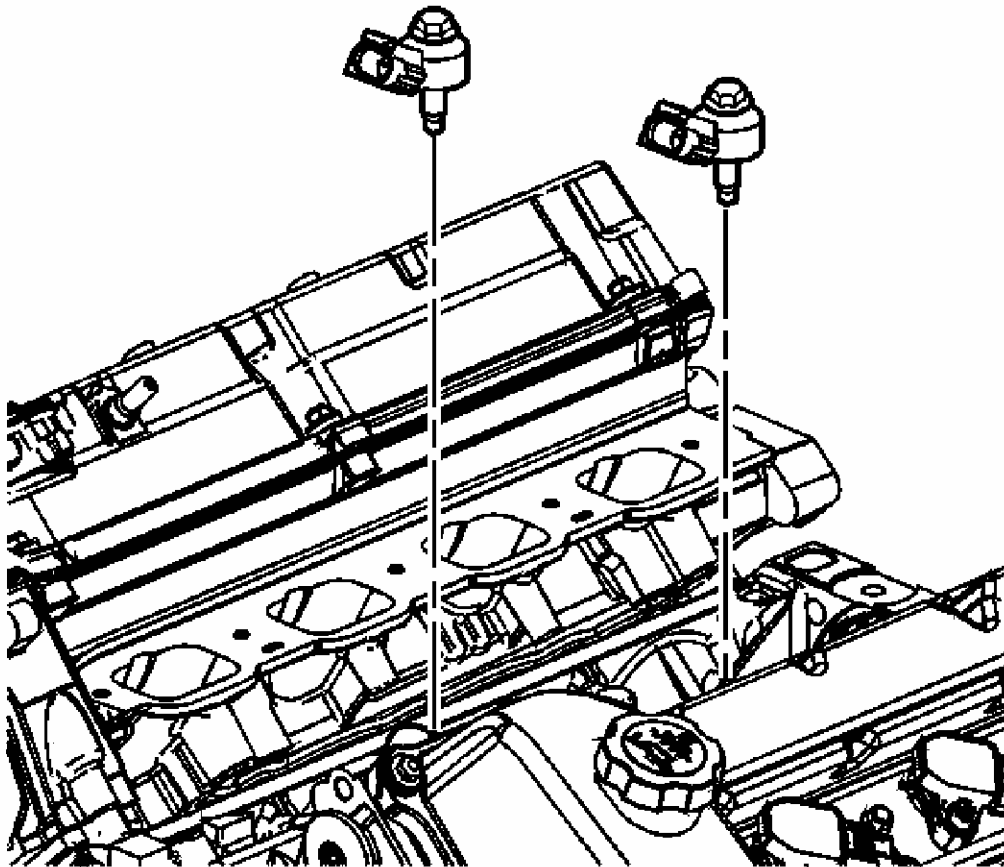


Fig. 241: Locating KS Sensors
Courtesy of GENERAL MOTORS CORP.

6. Remove the KS sensors.

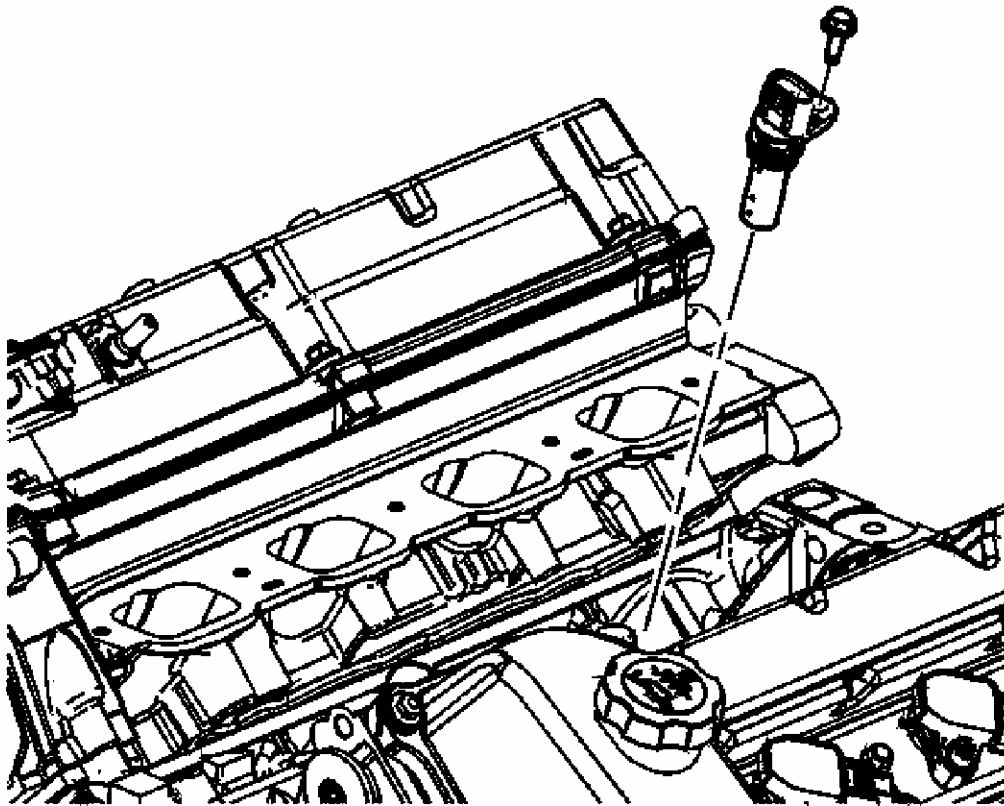


Fig. 242: Locating CKP Sensor
Courtesy of GENERAL MOTORS CORP.

7. Remove the CKP sensor bolt.
8. Remove the CKP sensor.

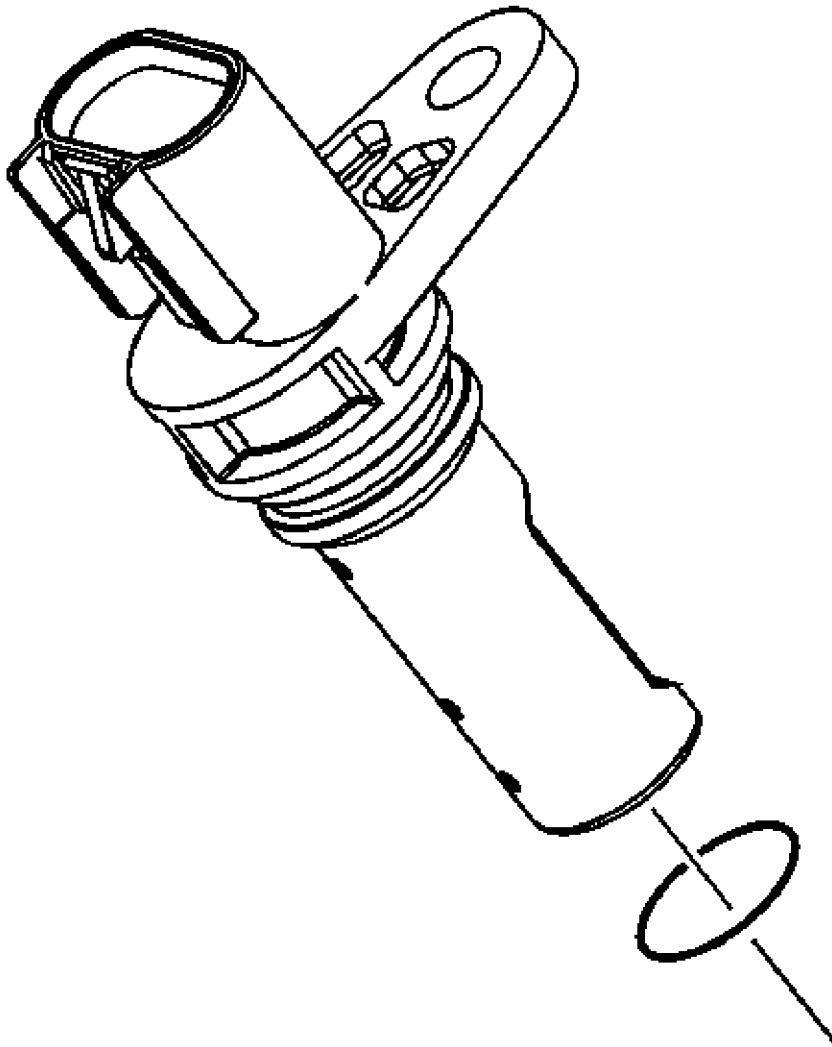


Fig. 243: View Of CKP Sensor O-Ring
Courtesy of GENERAL MOTORS CORP.

9. Remove and discard the CKP sensor O-ring.

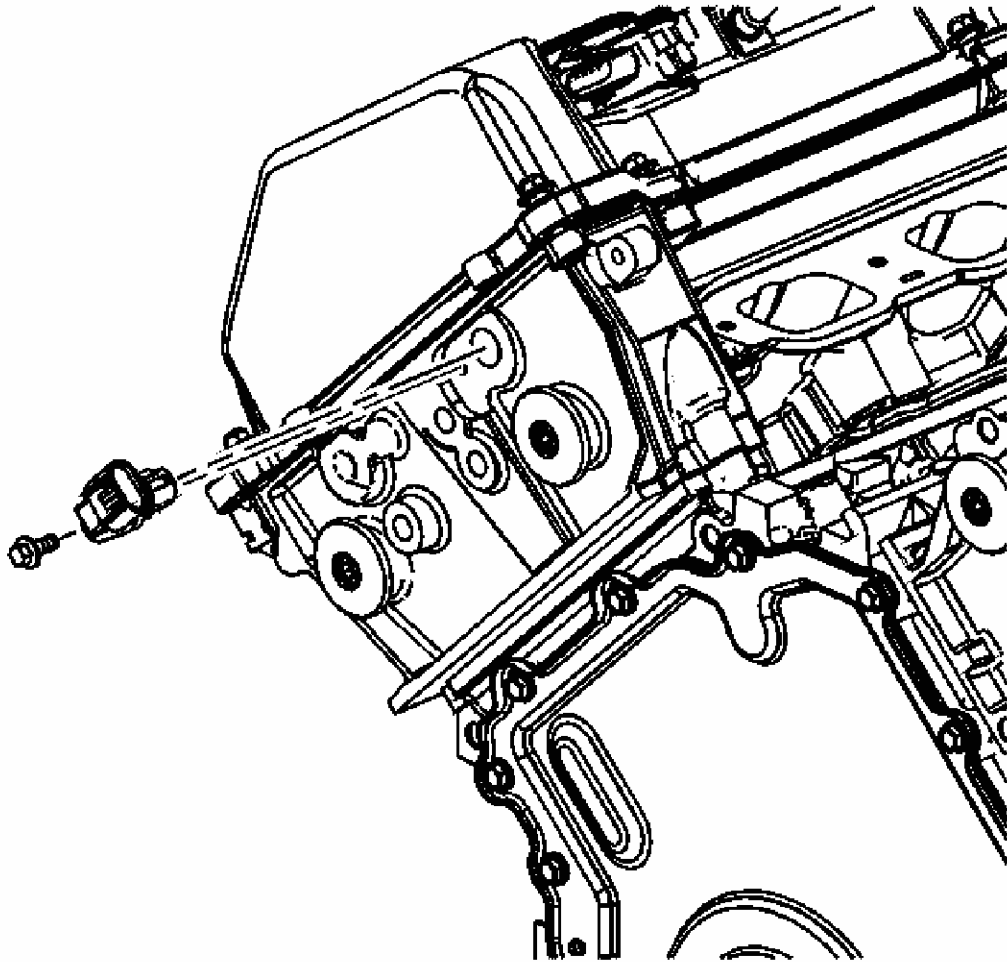


Fig. 244: Identifying CMP Sensor
Courtesy of GENERAL MOTORS CORP.

10. Remove the camshaft position CMP sensor bolt.
11. Remove the CMP sensor.

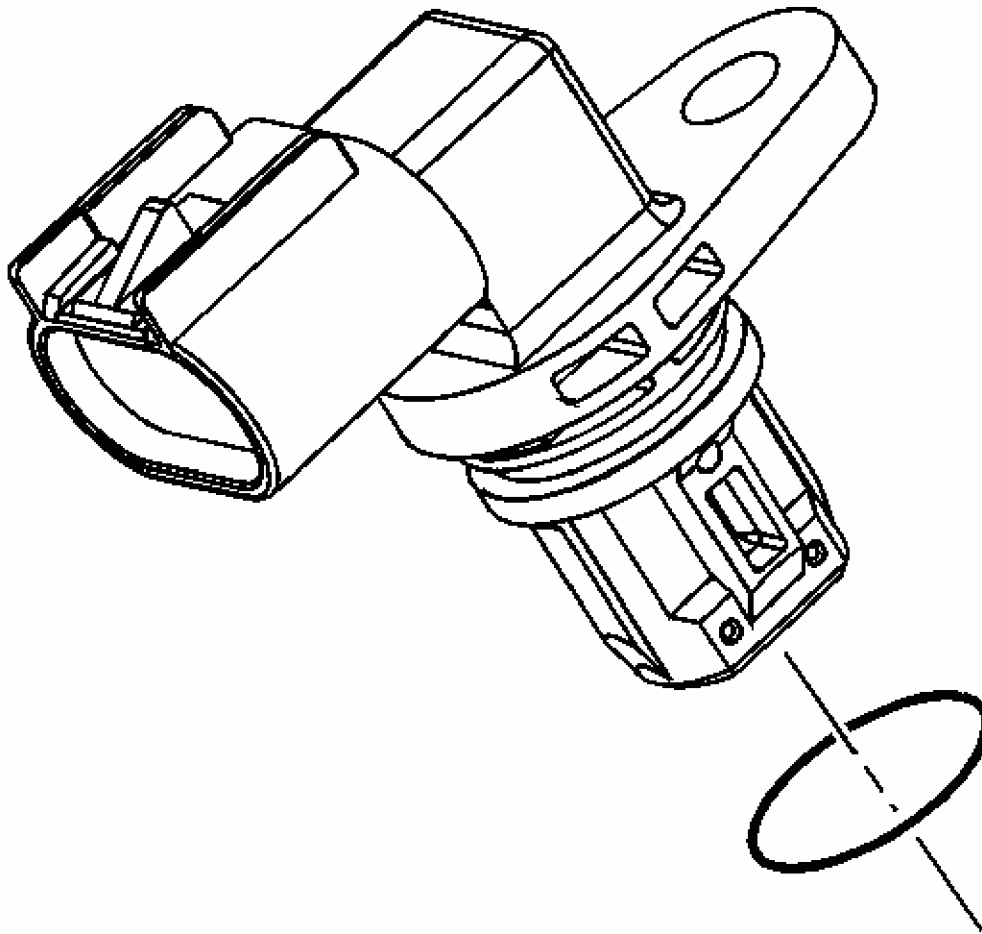


Fig. 245: Identifying CMP Sensor O-Ring
Courtesy of GENERAL MOTORS CORP.

12. Remove and discard the CMP sensor O-ring.

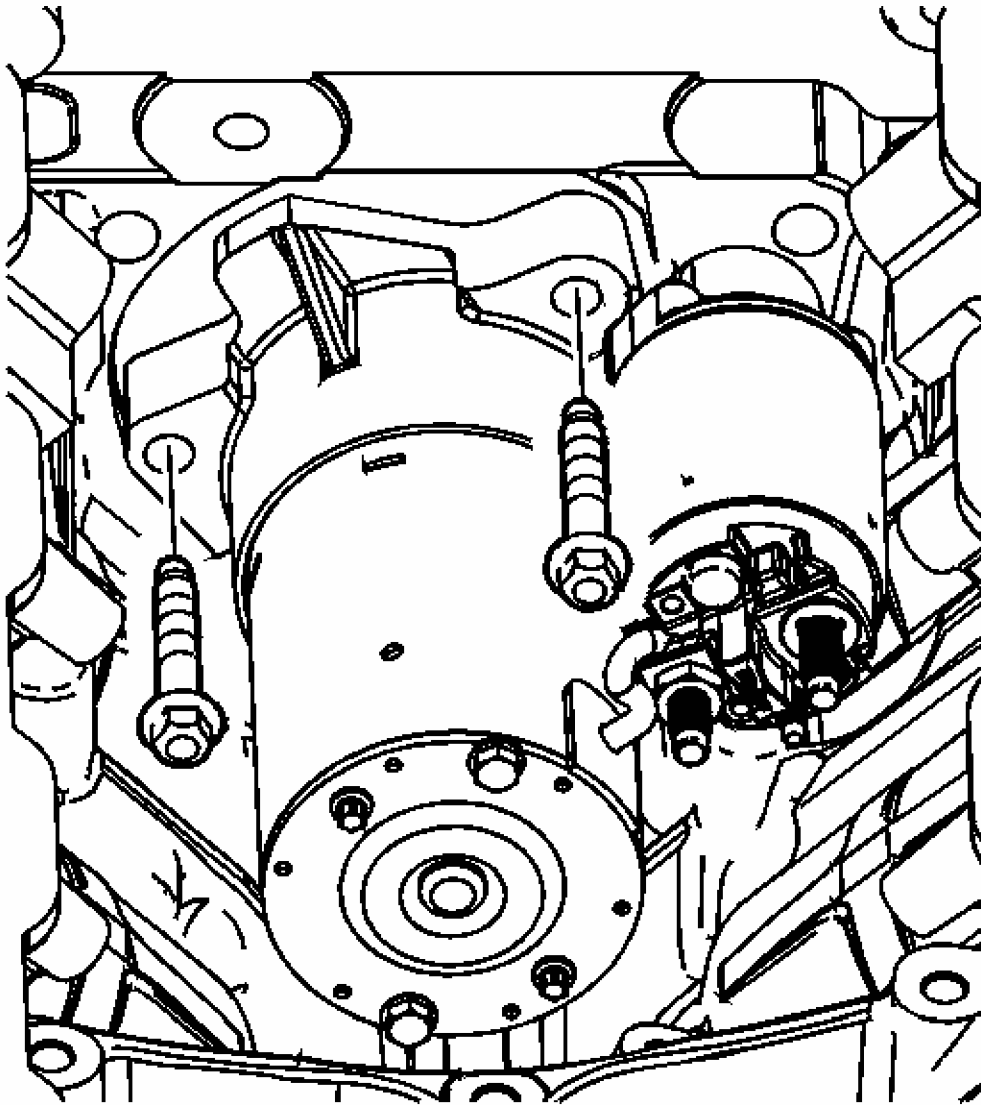


Fig. 246: Identifying Starter Motor Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove the 2 starter motor bolts.

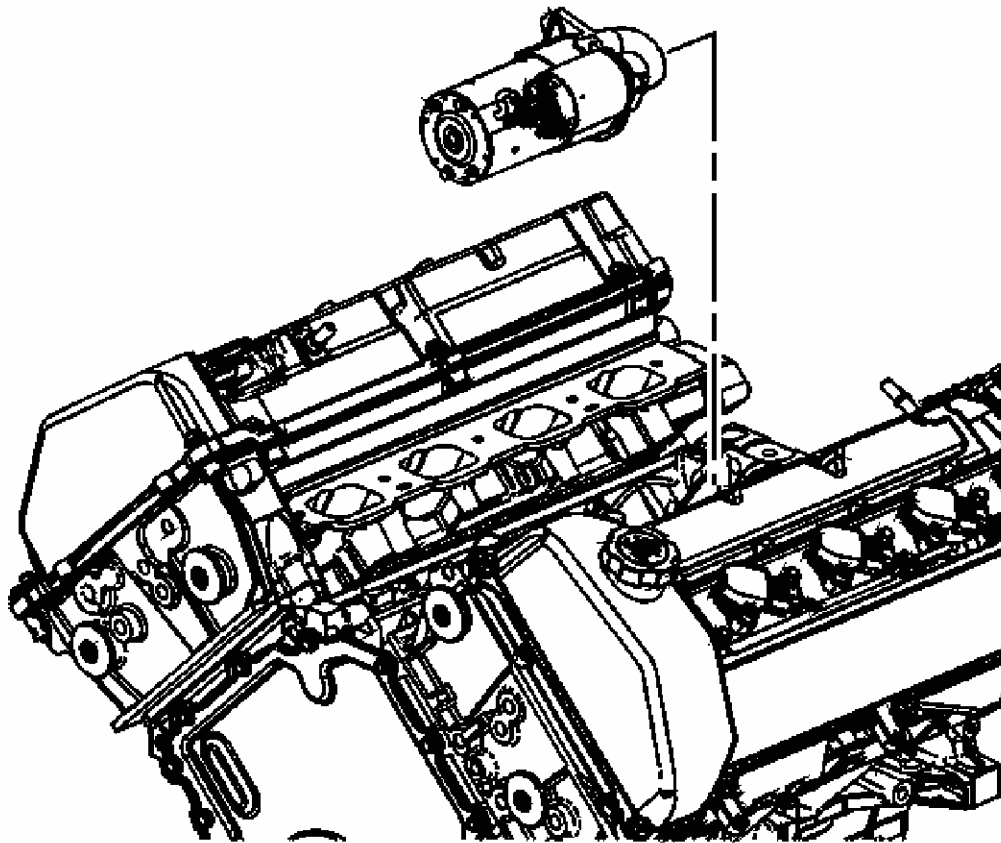


Fig. 247: Locating Starter Motor
Courtesy of GENERAL MOTORS CORP.

14. Using two hands, remove the starter motor and the wiring harness by sliding the motor toward the front of the engine. The wiring harness can remain attached unless replacing the starter.

IGNITION COIL MODULE REMOVAL - LEFT SIDE

REMOVAL PROCEDURE

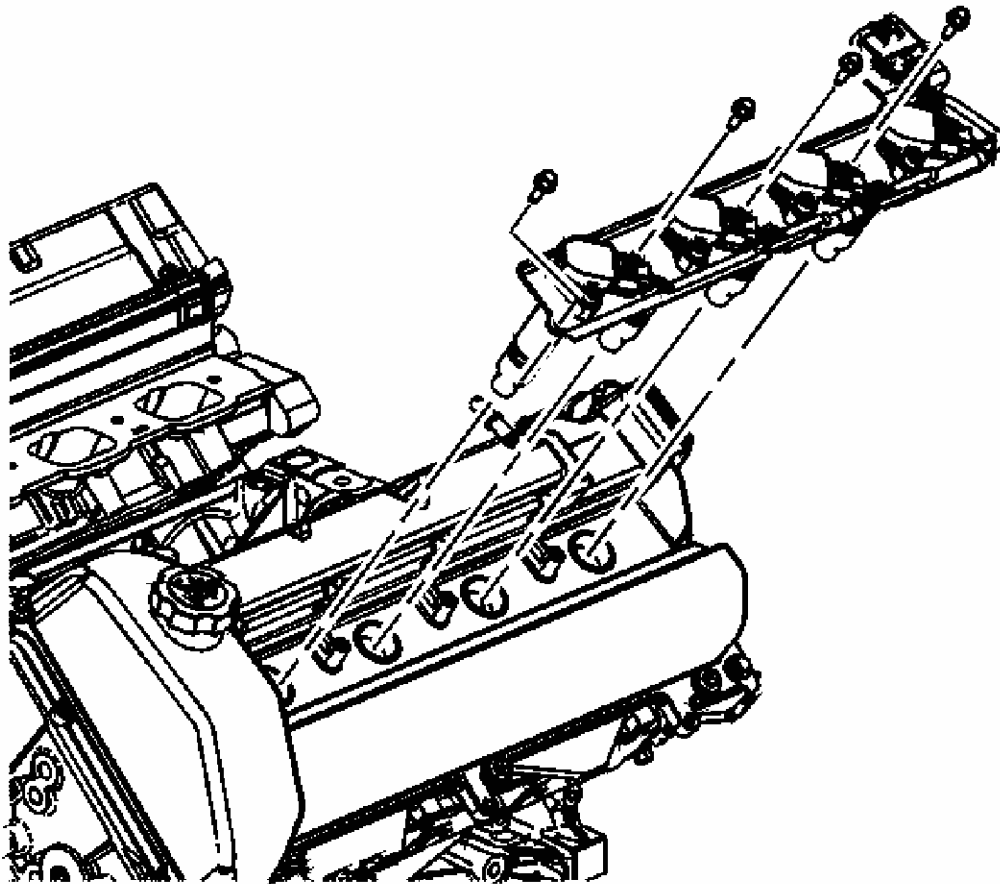


Fig. 248: Identifying Ignition Coil Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the ignition coil assembly bolts.
2. Remove the ignition coil assembly.

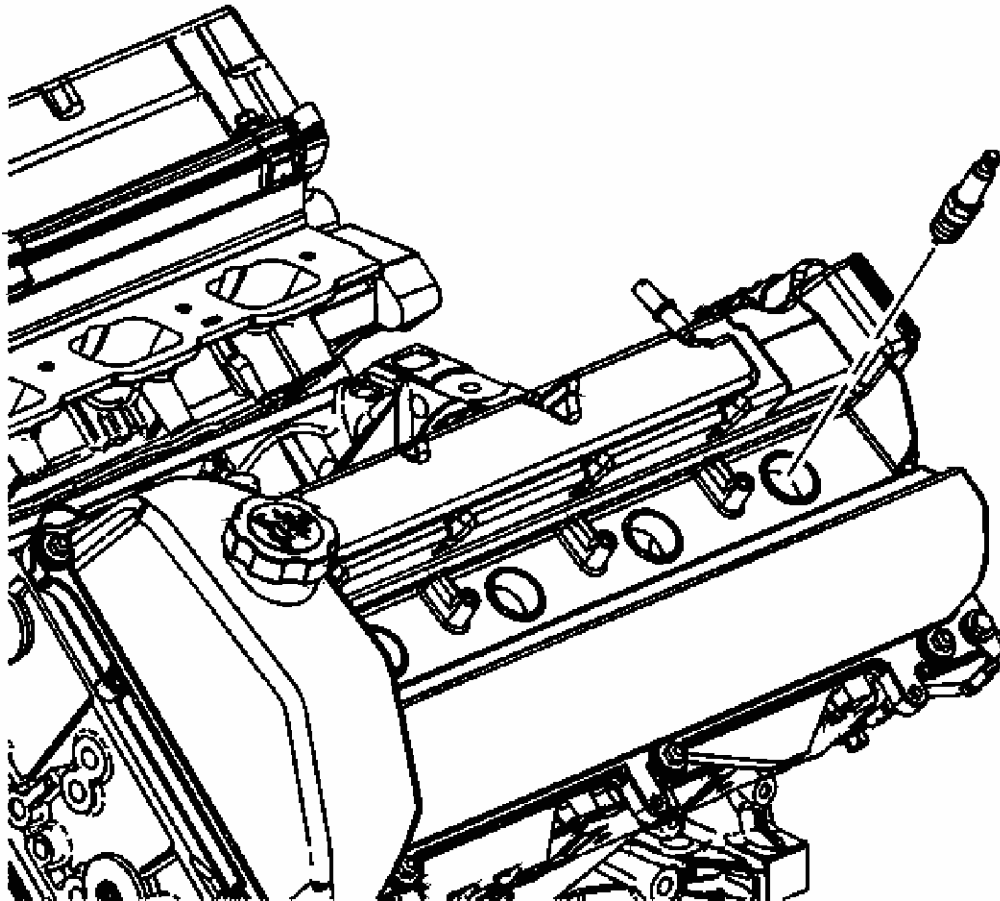


Fig. 249: Identifying Spark Plug
Courtesy of GENERAL MOTORS CORP.

3. Remove the left spark plugs.

IGNITION COIL MODULE REMOVAL - RIGHT SIDE

REMOVAL PROCEDURE

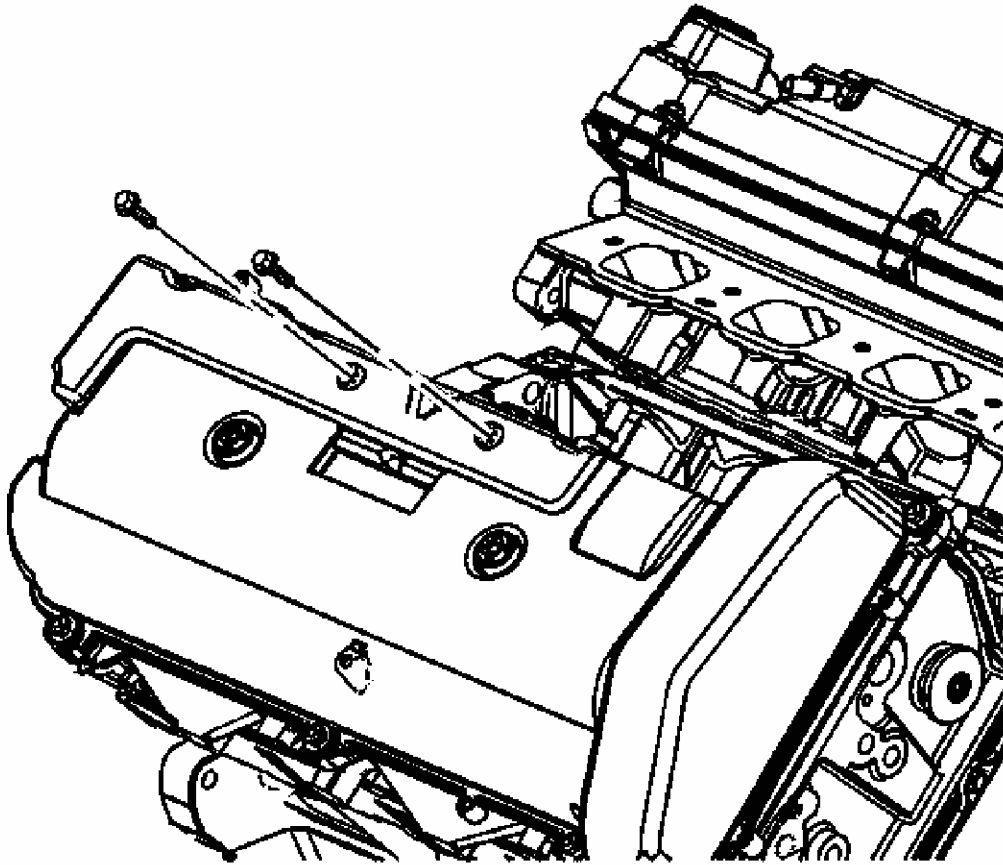


Fig. 250: Identifying Fuel Injector Sight Shield Bracket
Courtesy of GENERAL MOTORS CORP.

1. If equipped, remove the fuel injector sight shield bracket bolts.
2. Remove the fuel injector sight shield bracket.

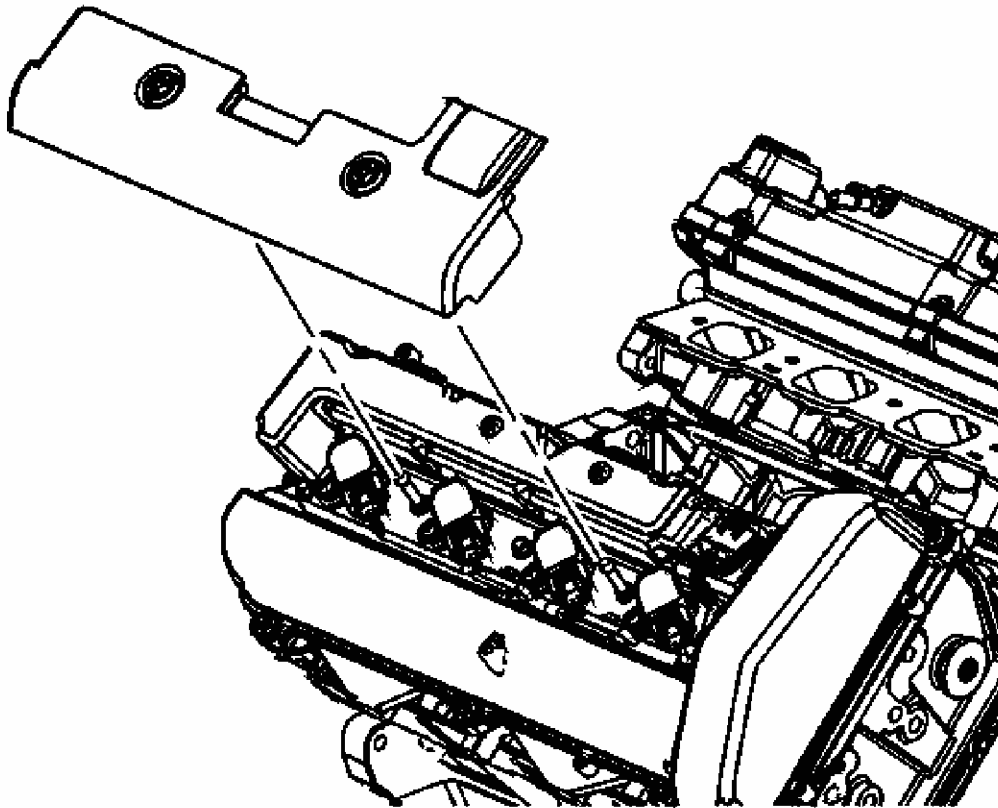


Fig. 251: Identifying Ignition Coil Assembly Sight Shield Cover
Courtesy of GENERAL MOTORS CORP.

3. Remove the ignition coil assembly sight shield cover.

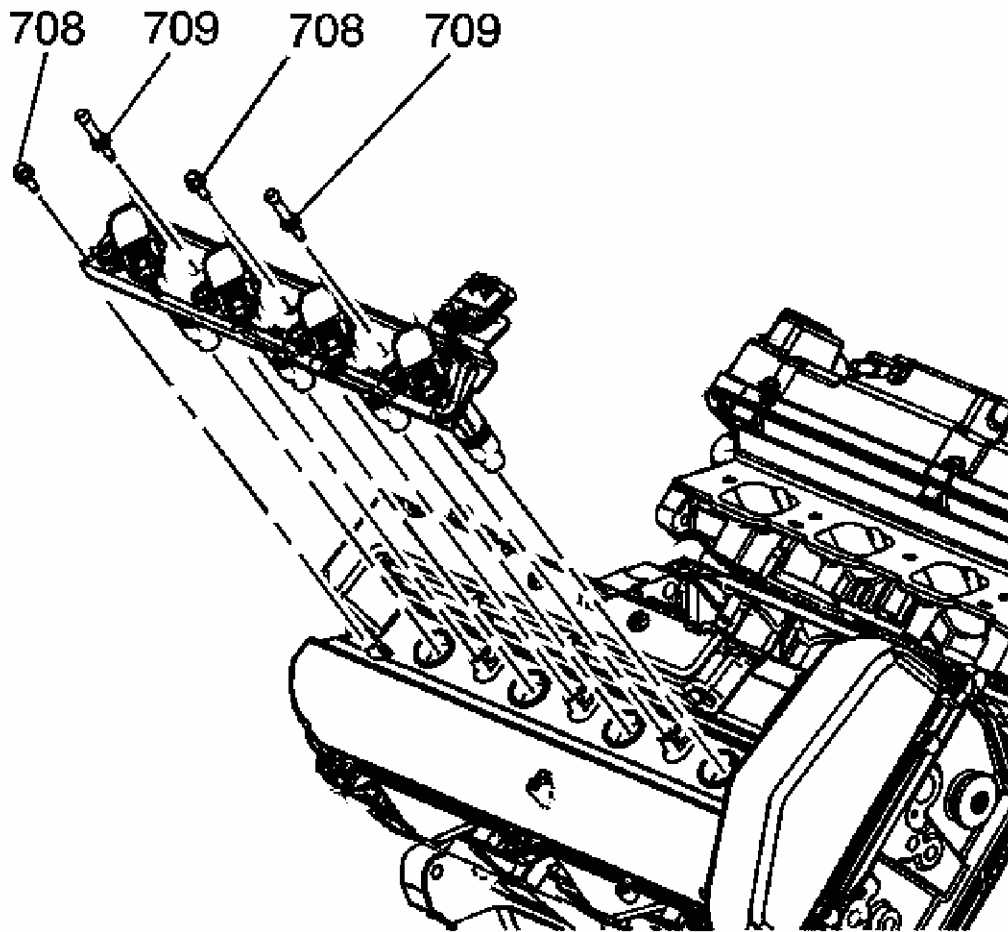


Fig. 252: Identifying Ignition Coil Assembly Bolts & Ball Studs
Courtesy of GENERAL MOTORS CORP.

4. Remove the ignition coil assembly bolts (708) and ball studs (709).
5. Remove the ignition coil assembly.

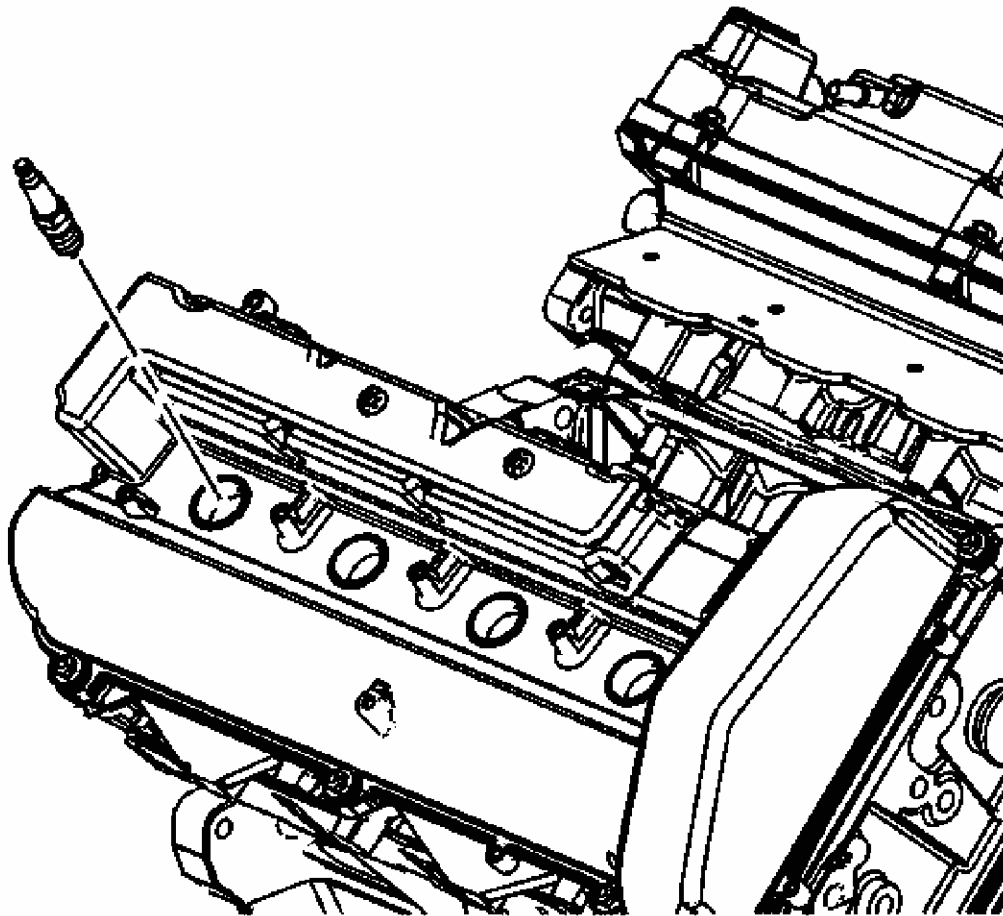


Fig. 253: Identifying Spark Plug
Courtesy of GENERAL MOTORS CORP.

6. Remove the right spark plugs.

CAMSHAFT COVER REMOVAL - LEFT SIDE

TOOLS REQUIRED

- **J 38825** Power Steering and Water Pump Pulley Remover
- **J 39946** Crankshaft Socket. See **Special Tools** 4.6L
- **J 44212** Camshaft Holding Tool. See **Special Tools** .

REMOVAL PROCEDURE

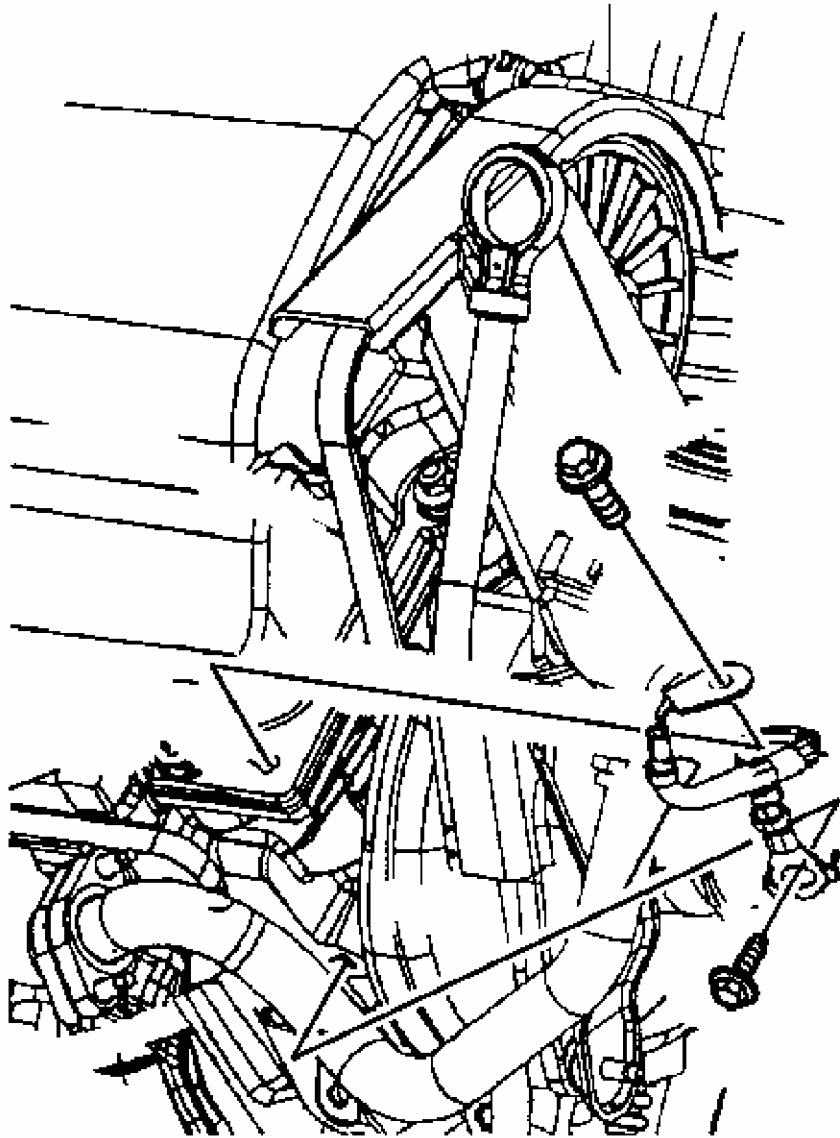


Fig. 254: Identifying Left Camshaft Cover Ignition Coil Ground Strap Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the left camshaft cover ignition coil ground strap bolt.
2. Remove the left cylinder head ignition coil ground strap bolt.
3. Remove the left ignition coil ground strap.

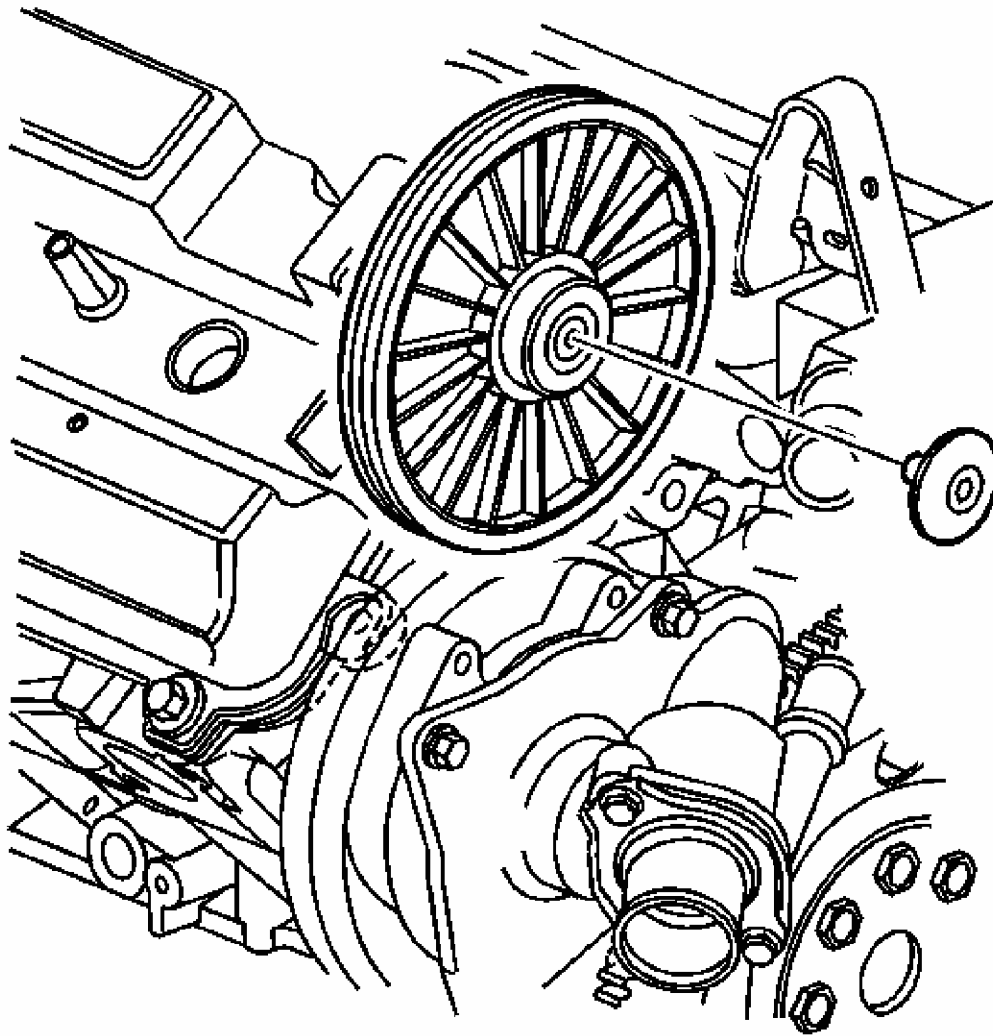


Fig. 255: Identifying Intake Camshaft End Cap
Courtesy of GENERAL MOTORS CORP.

4. Align the crankshaft to top dead center (TDC) using the J 39946 . See Special Tools .
5. Remove the end cap from the intake camshaft.

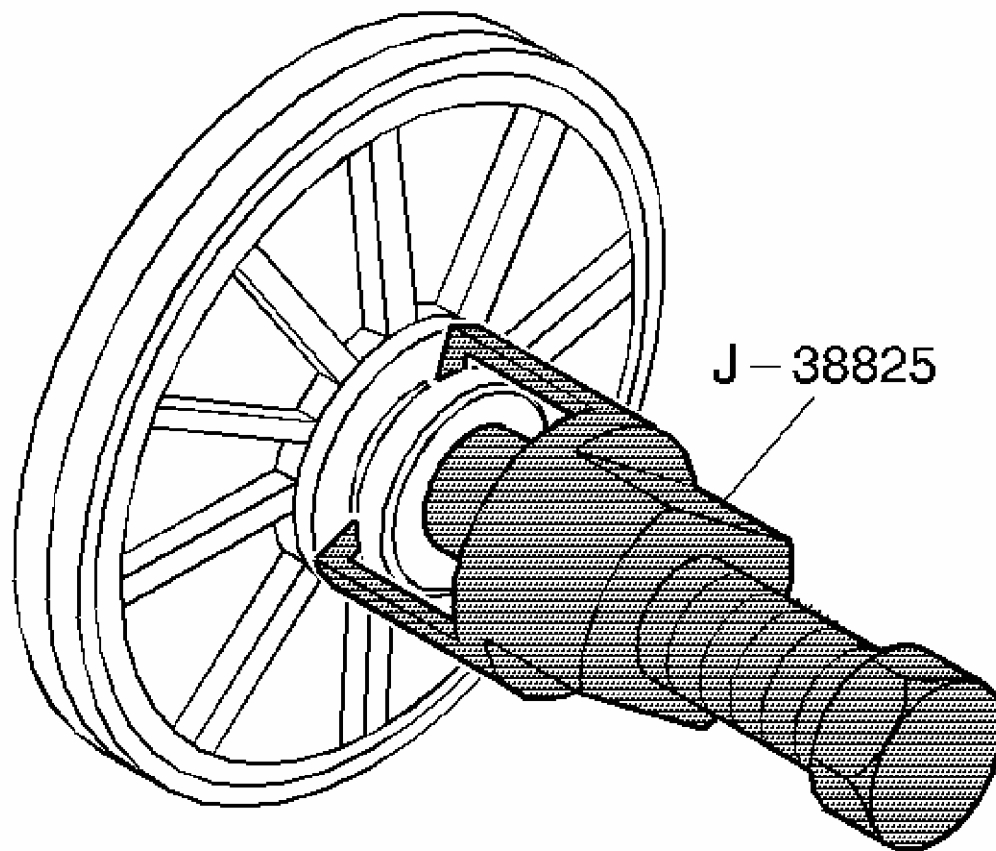


Fig. 256: View of J 38825

Courtesy of GENERAL MOTORS CORP.

6. Remove the water pump drive pulley from the intake camshaft using the **J 38825** .

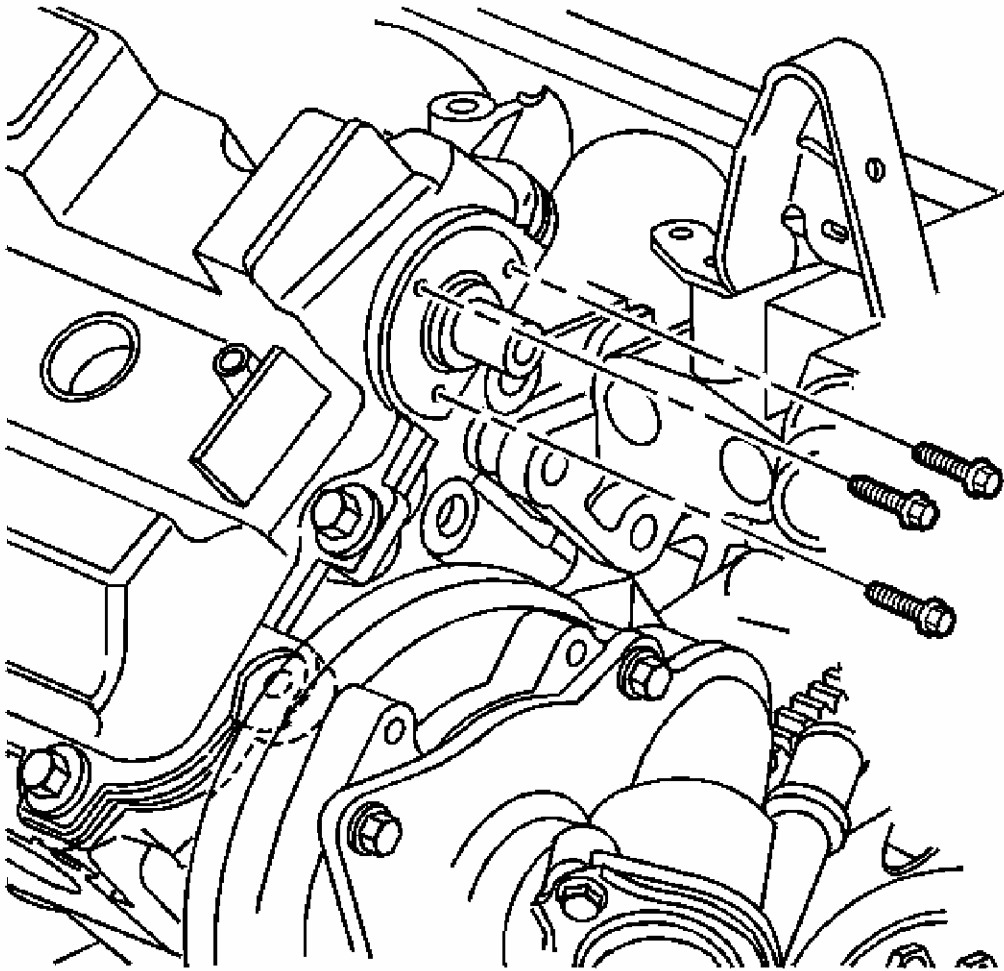


Fig. 257: Identifying Camshaft Seal Screws
Courtesy of GENERAL MOTORS CORP.

7. Remove the camshaft seal screws.

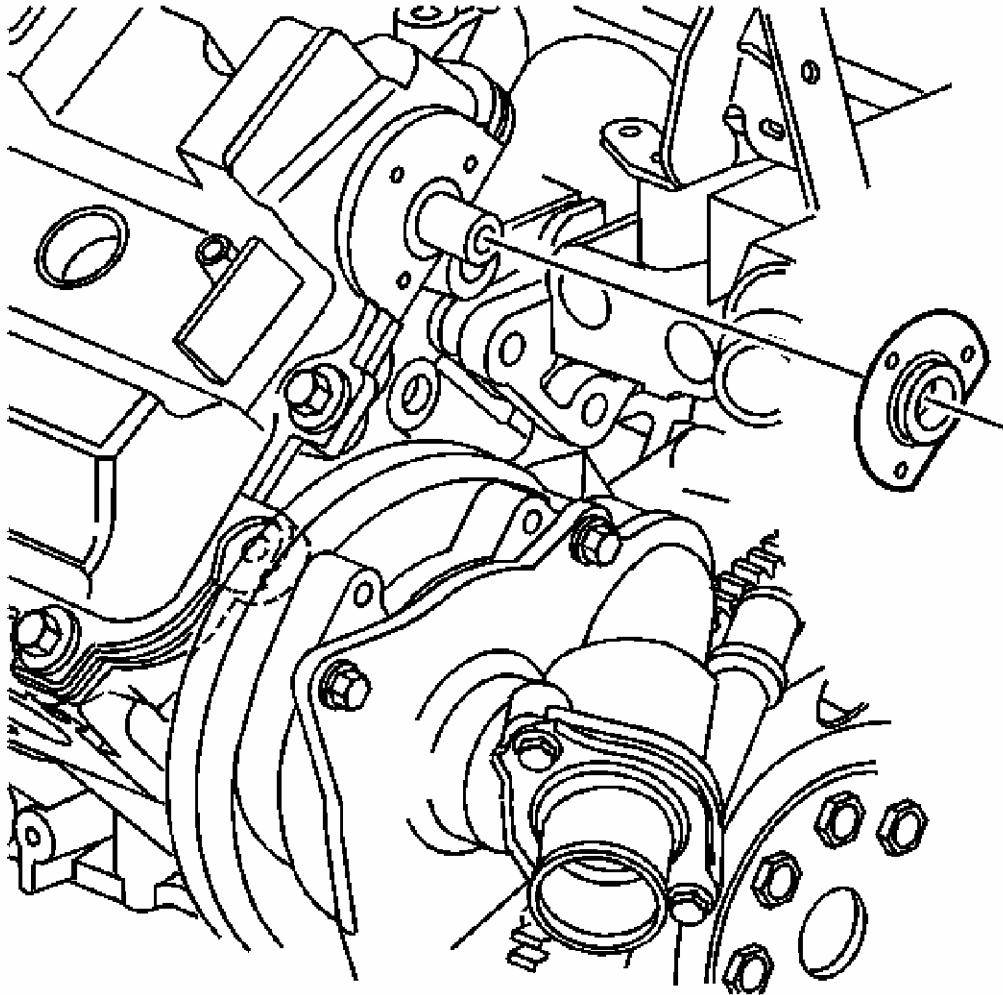


Fig. 258: View Of Camshaft Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the camshaft seal.

8. Slide the seal off the end of the camshaft.

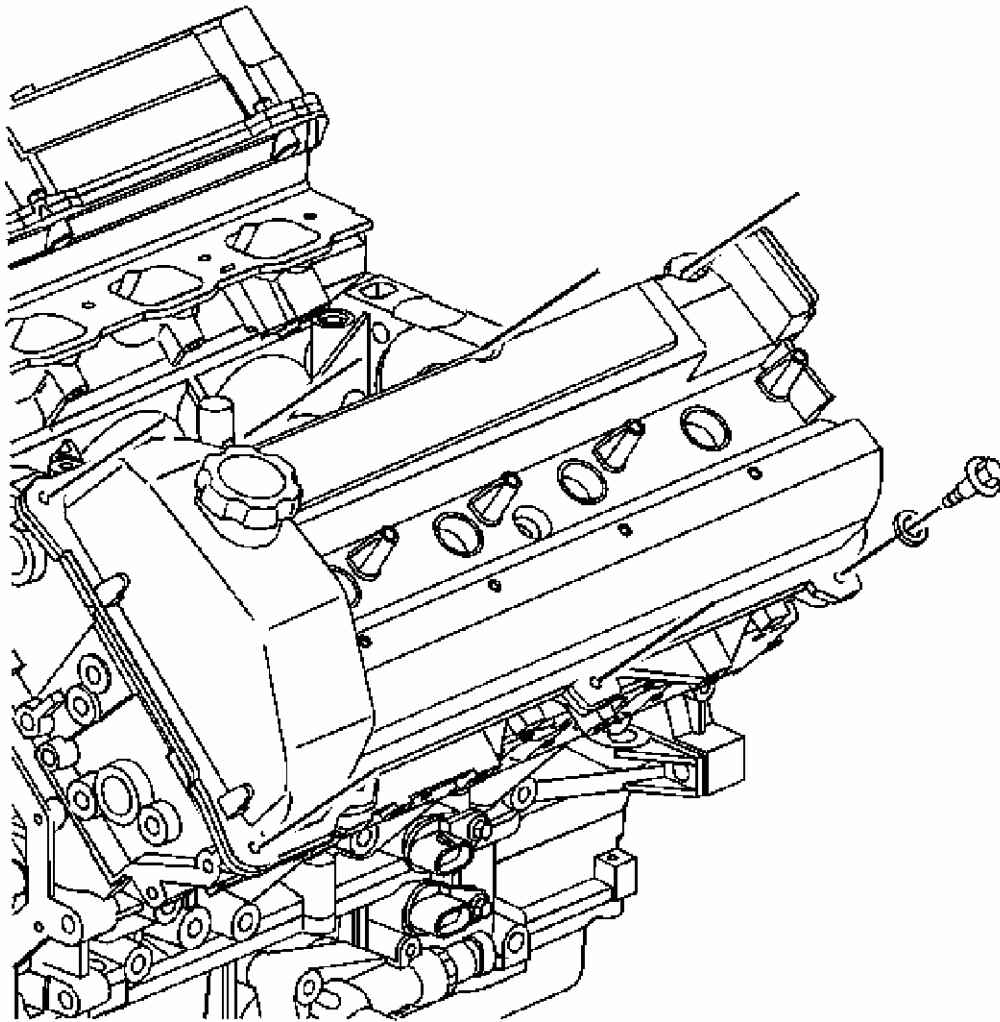


Fig. 259: Identifying Camshaft Cover Bolts
Courtesy of GENERAL MOTORS CORP.

9. Loosen the camshaft cover bolts.

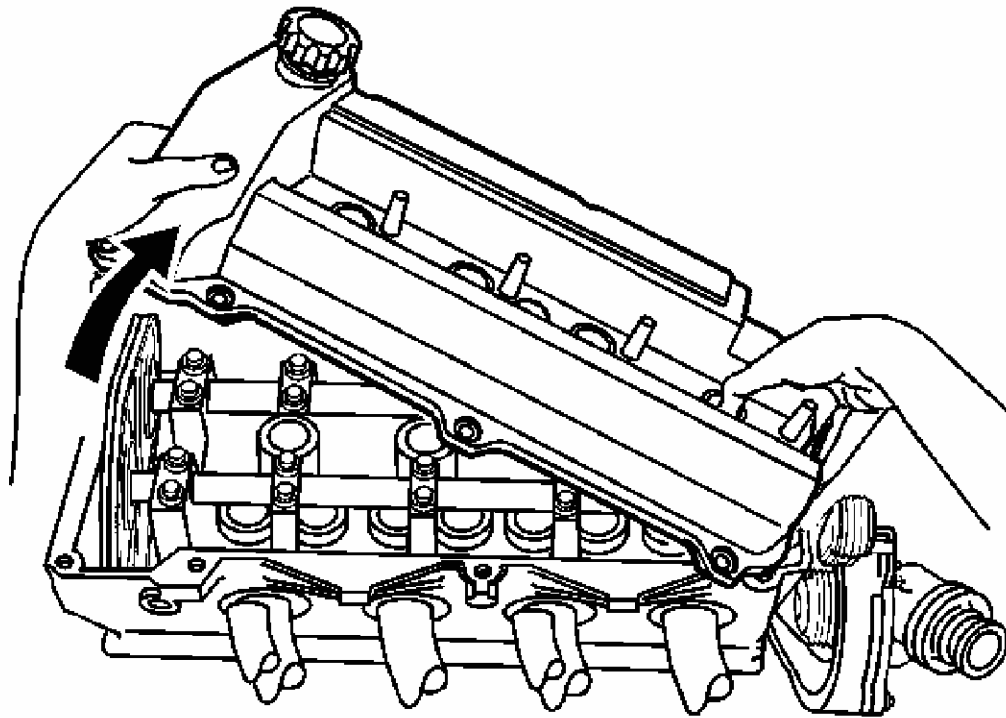


Fig. 260: Lifting Cover

Courtesy of GENERAL MOTORS CORP.

10. Lift up the front of the cover approximately 250 mm (10 in).

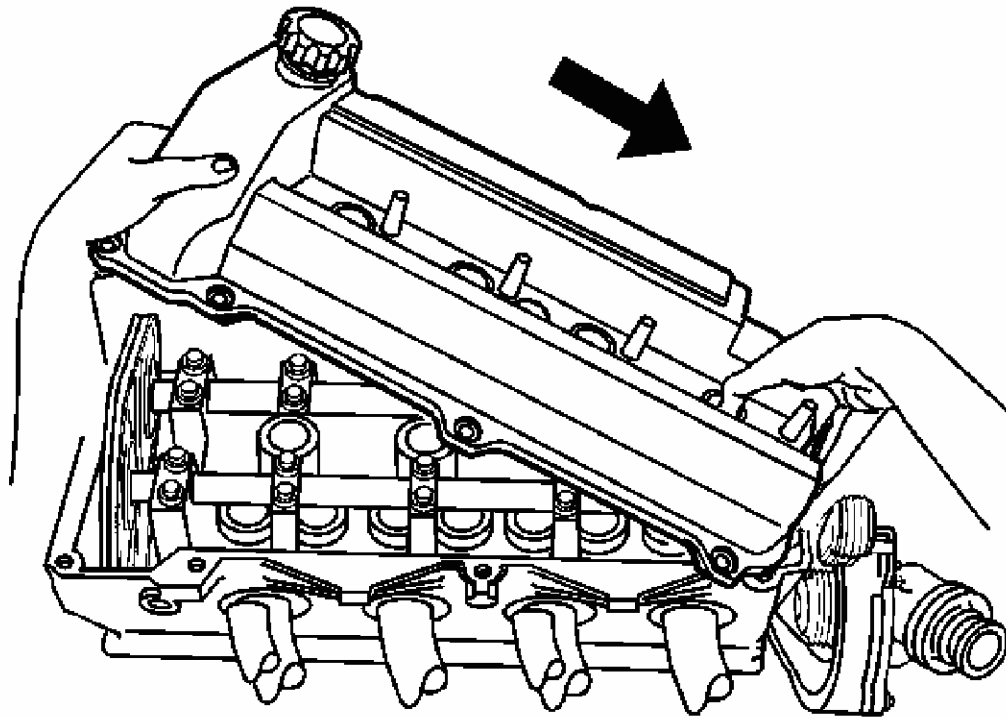


Fig. 261: Removing Front Of Cover
Courtesy of GENERAL MOTORS CORP.

11. Swing the front of the cover over the intake manifold while sliding the entire cover over the end of the camshaft.
12. The camshaft cover seals, perimeter and spark plug, should be reused unless they are damaged or if the perimeter seal is pulled from its groove during removal.

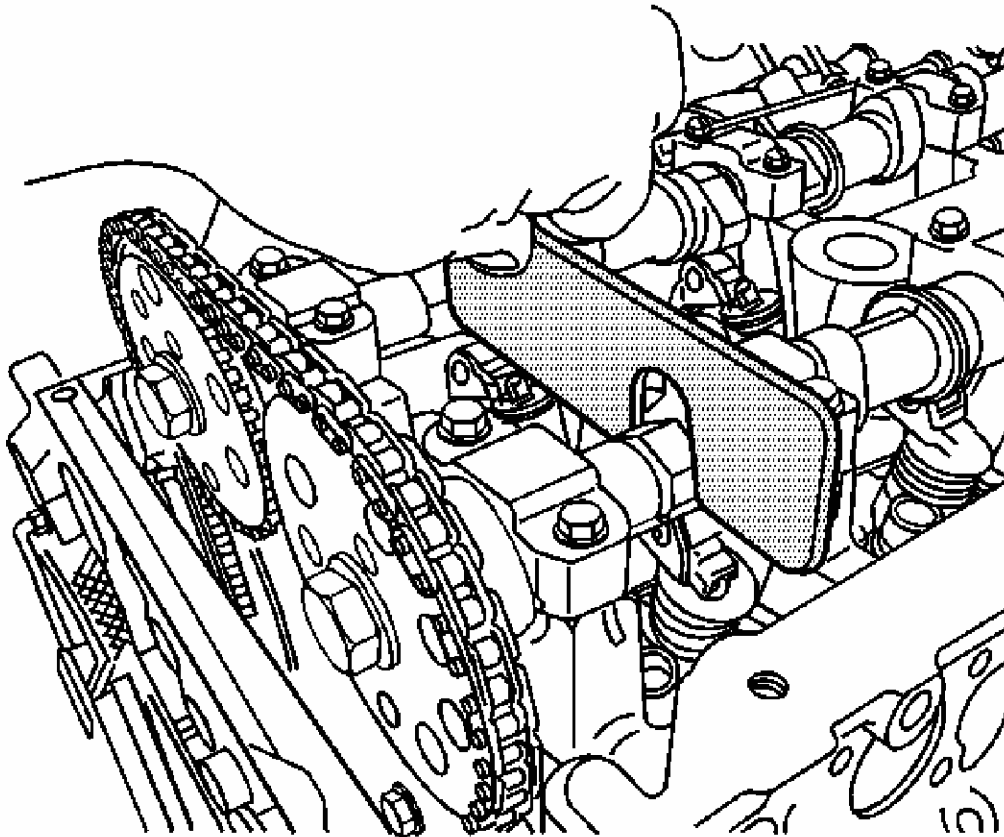


Fig. 262: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

13. Install the **J 44212** to the left cylinder head camshafts. See **Special Tools** .

CAMSHAFT COVER REMOVAL - RIGHT SIDE

TOOLS REQUIRED

J 44212 Camshaft Holding Tool. See **Special Tools** .

REMOVAL PROCEDURE

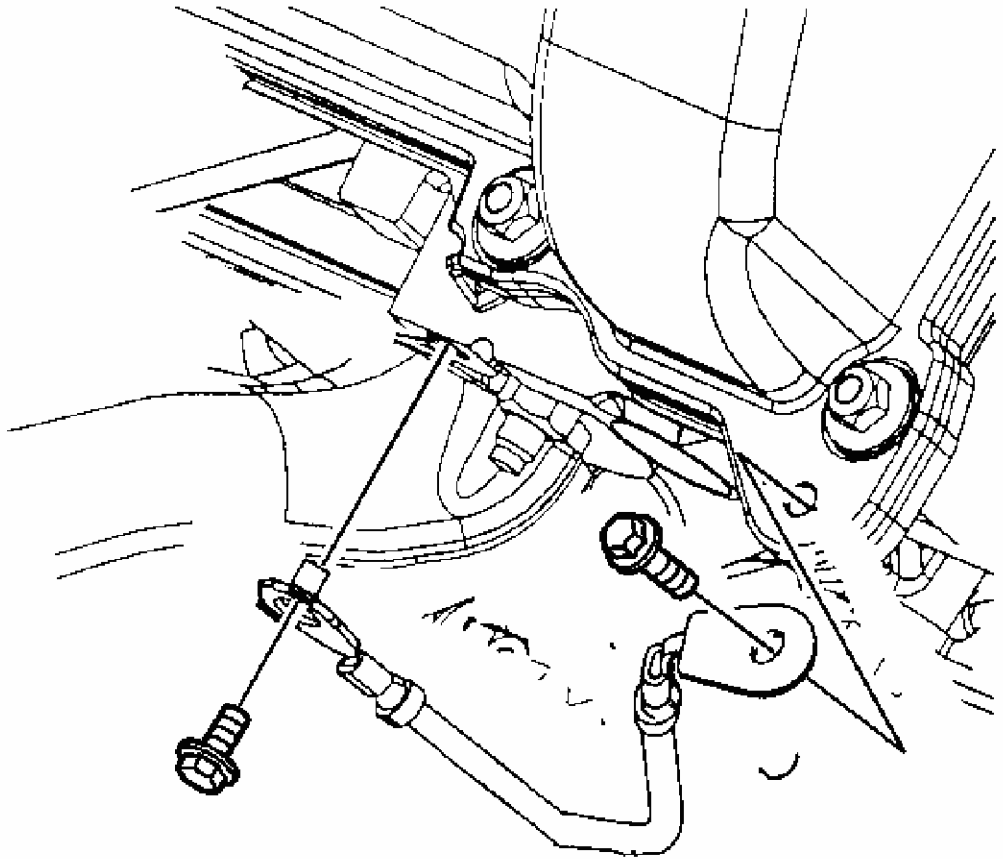


Fig. 263: Identifying Ignition Coil Ground Strap & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the right camshaft cover ignition coil ground strap bolt.
2. Remove the right cylinder head ignition coil ground strap bolt.
3. Remove the right ignition coil ground strap.

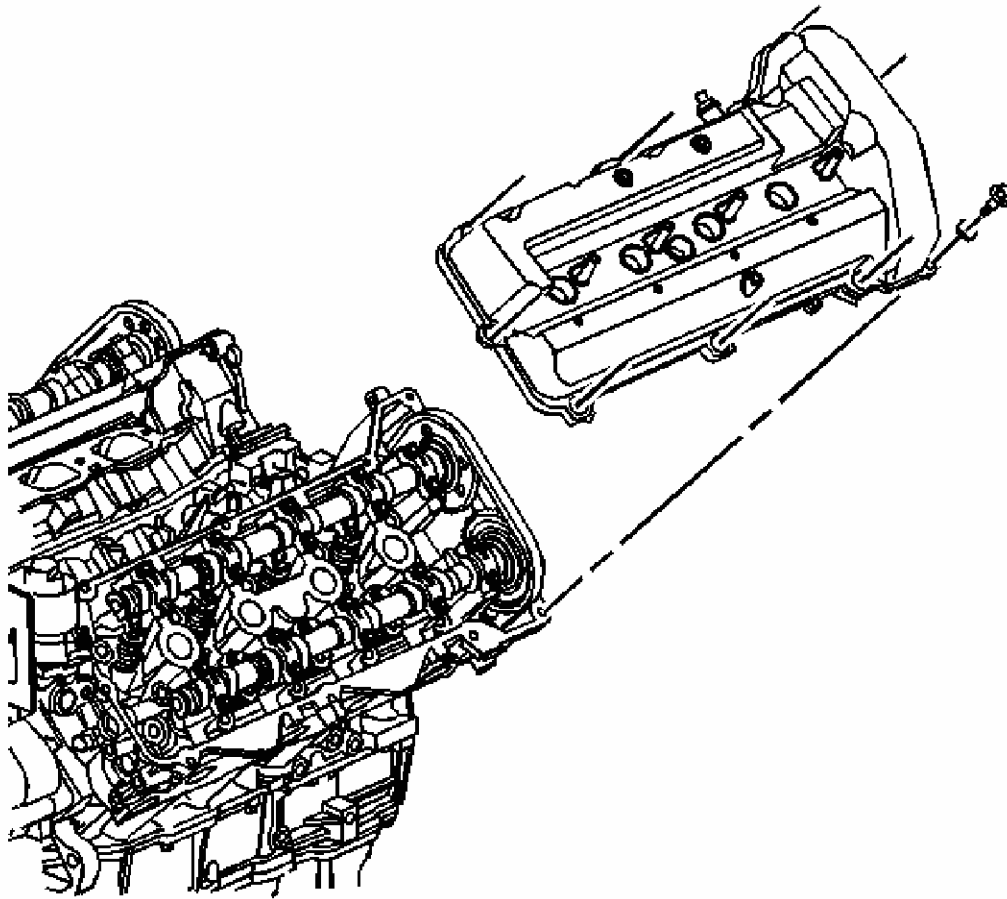


Fig. 264: Identifying Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft cover bolts.
5. Lift the camshaft cover from the cylinder head.

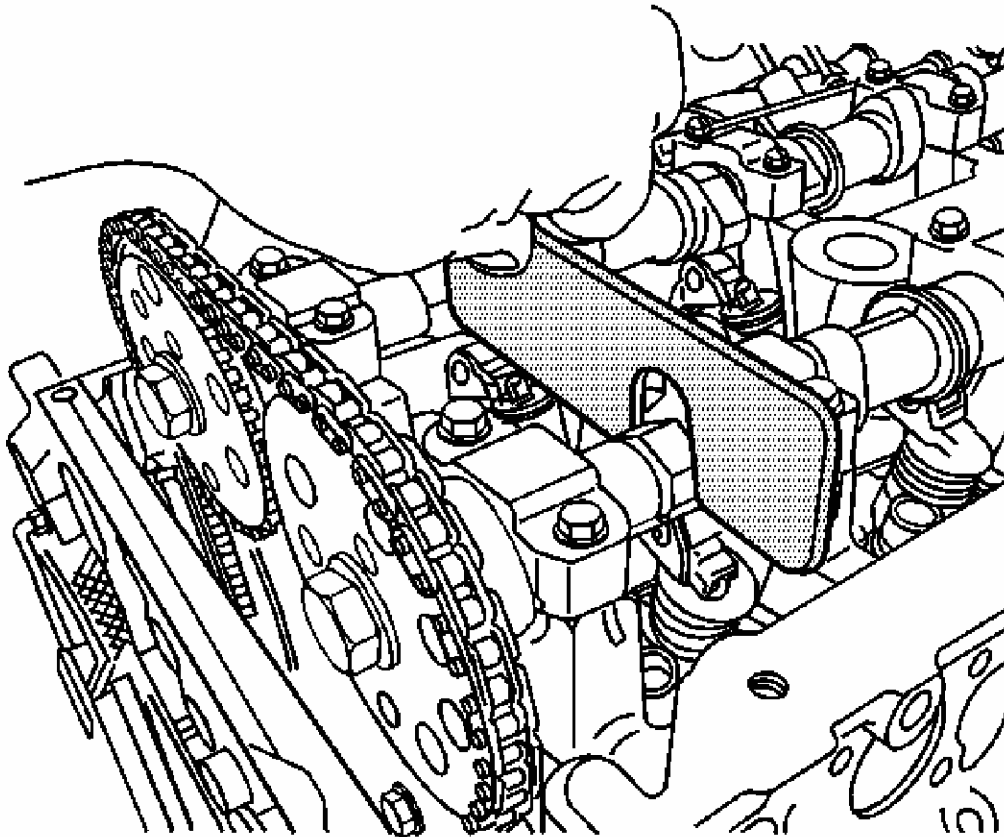


Fig. 265: Using Camshaft Holding Tool
Courtesy of GENERAL MOTORS CORP.

6. Install the **J 44212** to the right cylinder head camshafts. See **Special Tools** .

ENGINE FRONT COVER REMOVAL

REMOVAL PROCEDURE

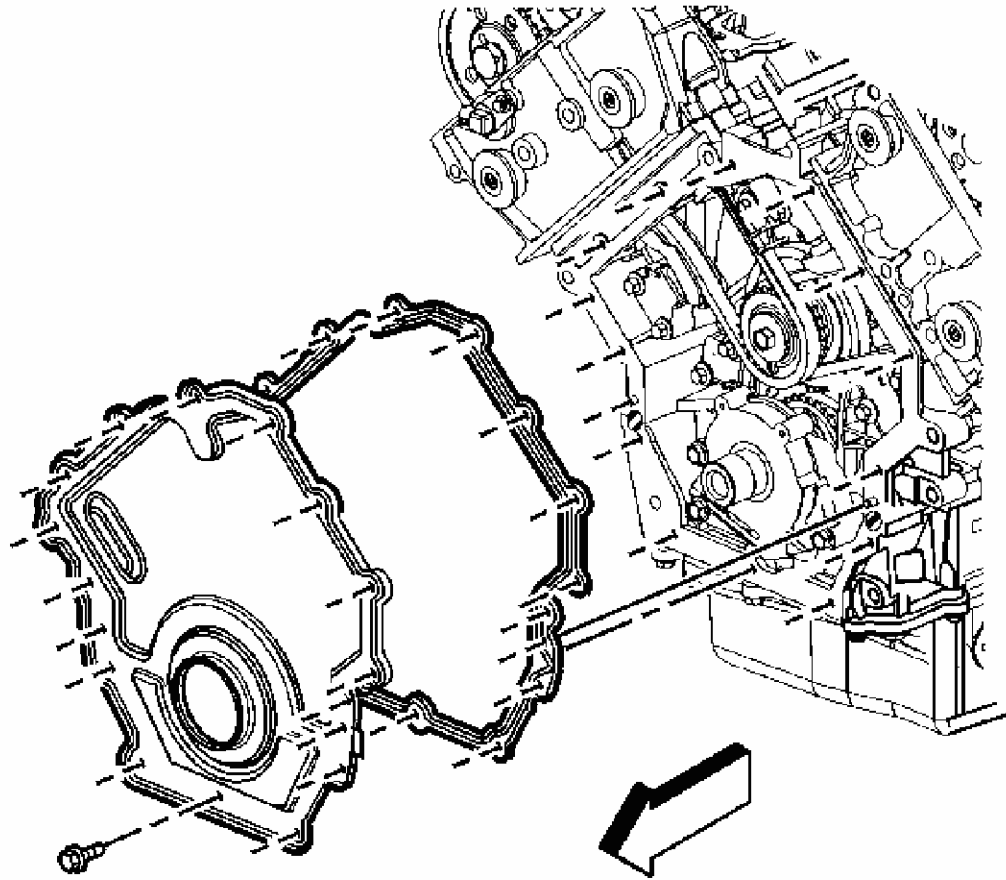


Fig. 266: View Of Engine Front Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the front cover perimeter bolts.
2. Remove the front cover and the gasket. Ensure that you do not damage the sealing surface.

CRANKSHAFT FRONT OIL SEAL REMOVAL

IMPORTANT: Do not remove the crankshaft front oil seal.

The crankshaft front oil seal is not serviced as an individual component. When replacing the crankshaft front oil seal, install a NEW engine front cover. In order to precisely align the crankshaft front oil seal to the crankshaft balancer and crankshaft balancer dust shield, the engine front cover and the crankshaft front oil seal are sold as an assembly.

OIL PUMP REMOVAL

REMOVAL PROCEDURE

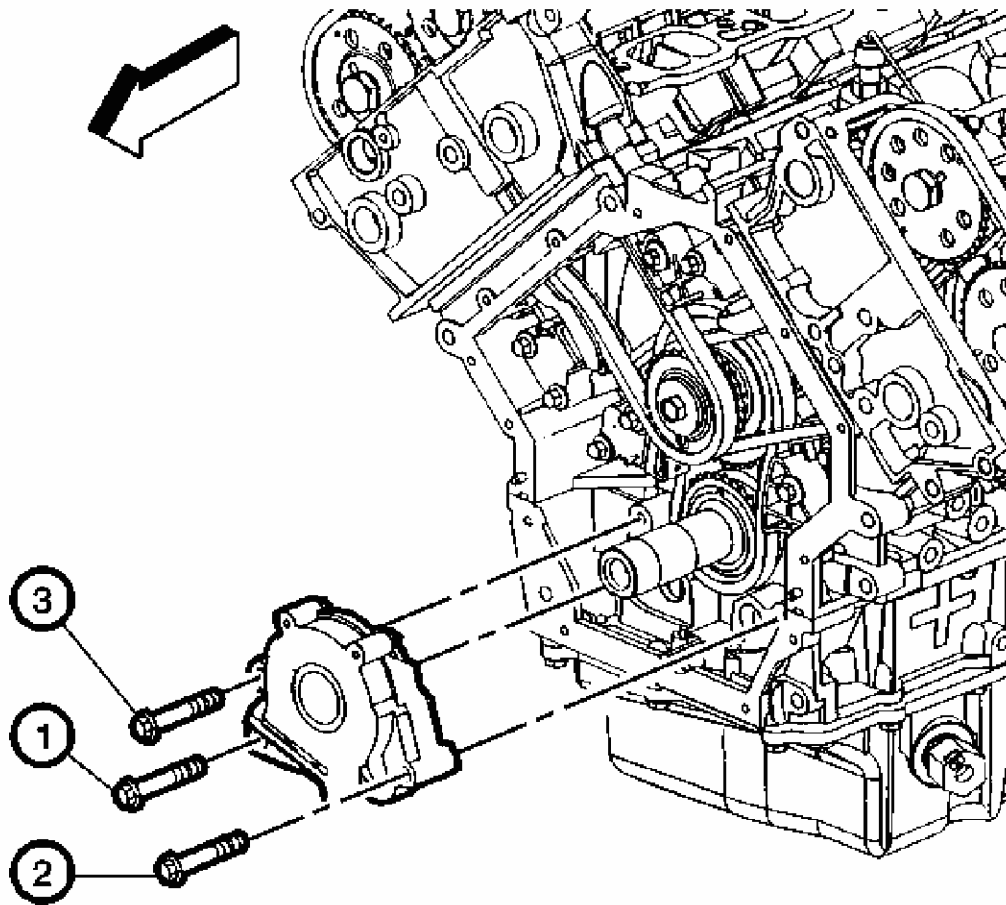


Fig. 267: Identifying Oil Pump Assembly Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump assembly retaining bolts (1, 2, 3) identified by the larger head size.
2. Slide the oil pump assembly off the nose of the crankshaft with the drive collar in place.
3. Wrap the oil pump in a towel for safe, clean storage until inspection or assembly is necessary.

SECONDARY CAMSHAFT DRIVE CHAIN REMOVAL - RIGHT SIDE

REMOVAL PROCEDURE

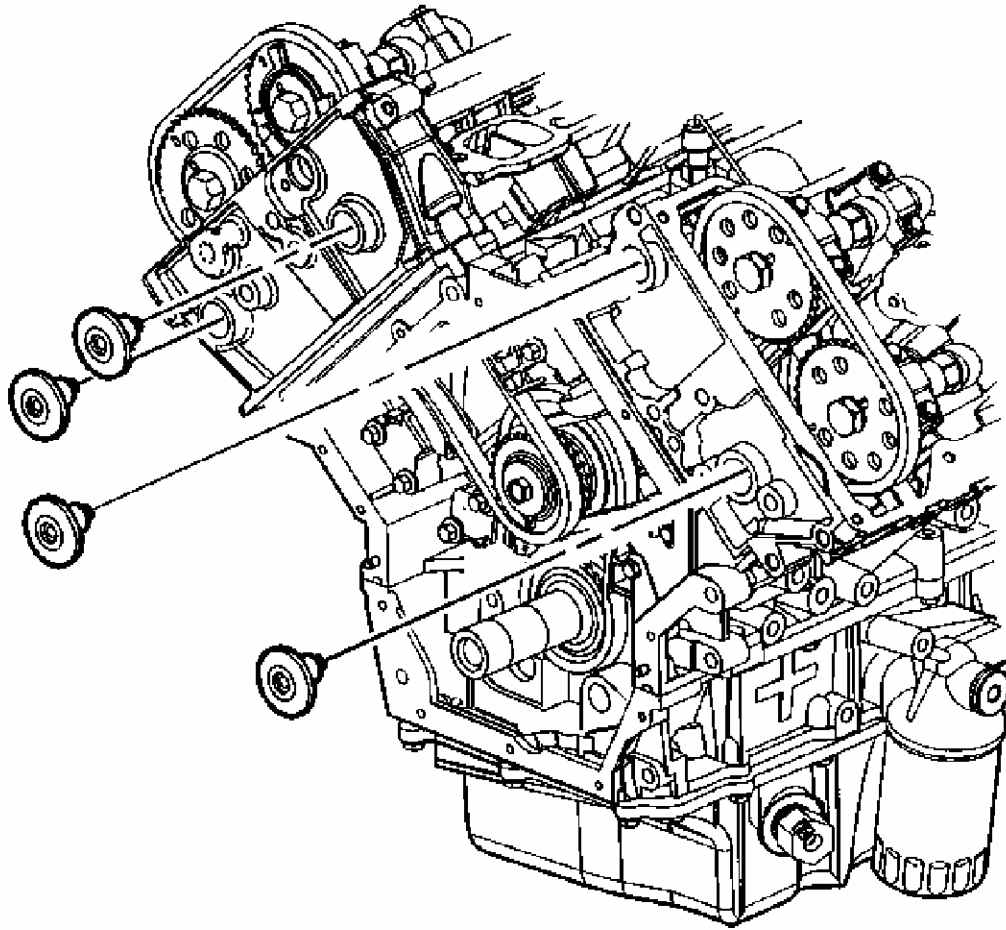


Fig. 268: Identifying Cylinder Head Core Hole Plugs
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head core hole plugs located in the cylinder heads. Ensure the O-ring seal is on each access plug.

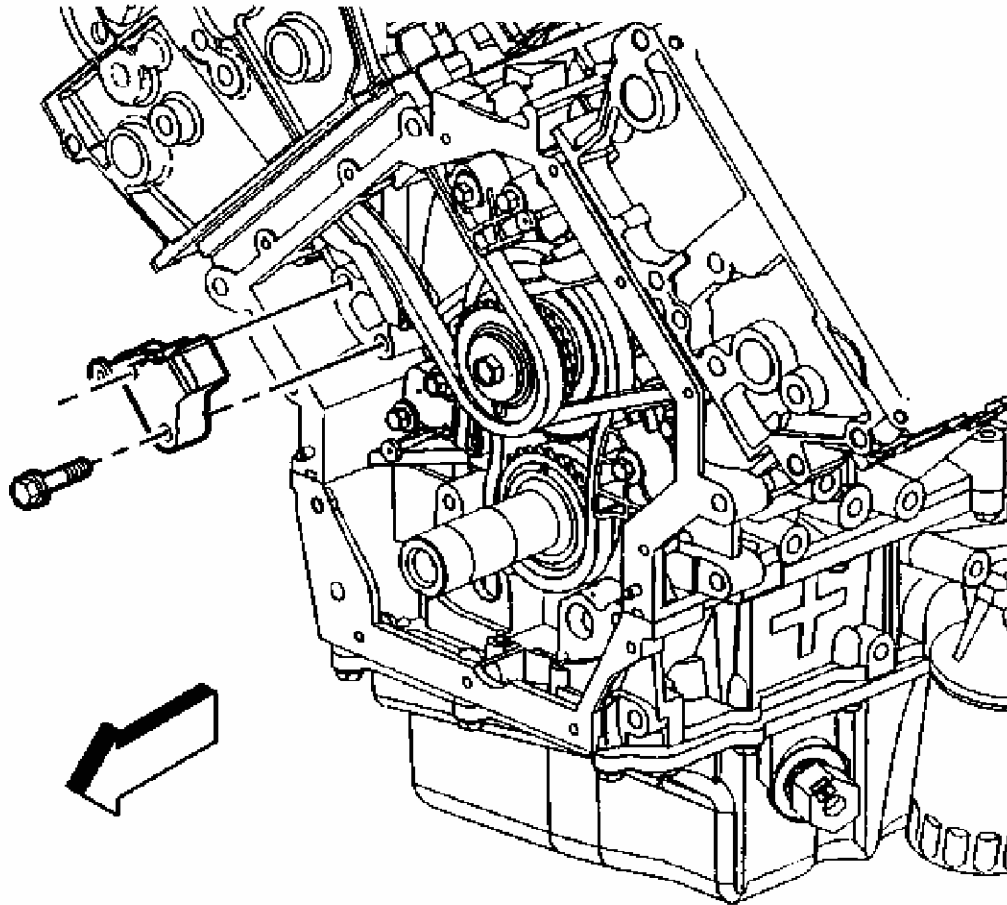


Fig. 269: View Of Right Secondary Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the right secondary drive chain tensioner bolts.
3. Remove the right secondary camshaft drive chain tensioner allowing it to expand as you remove it.

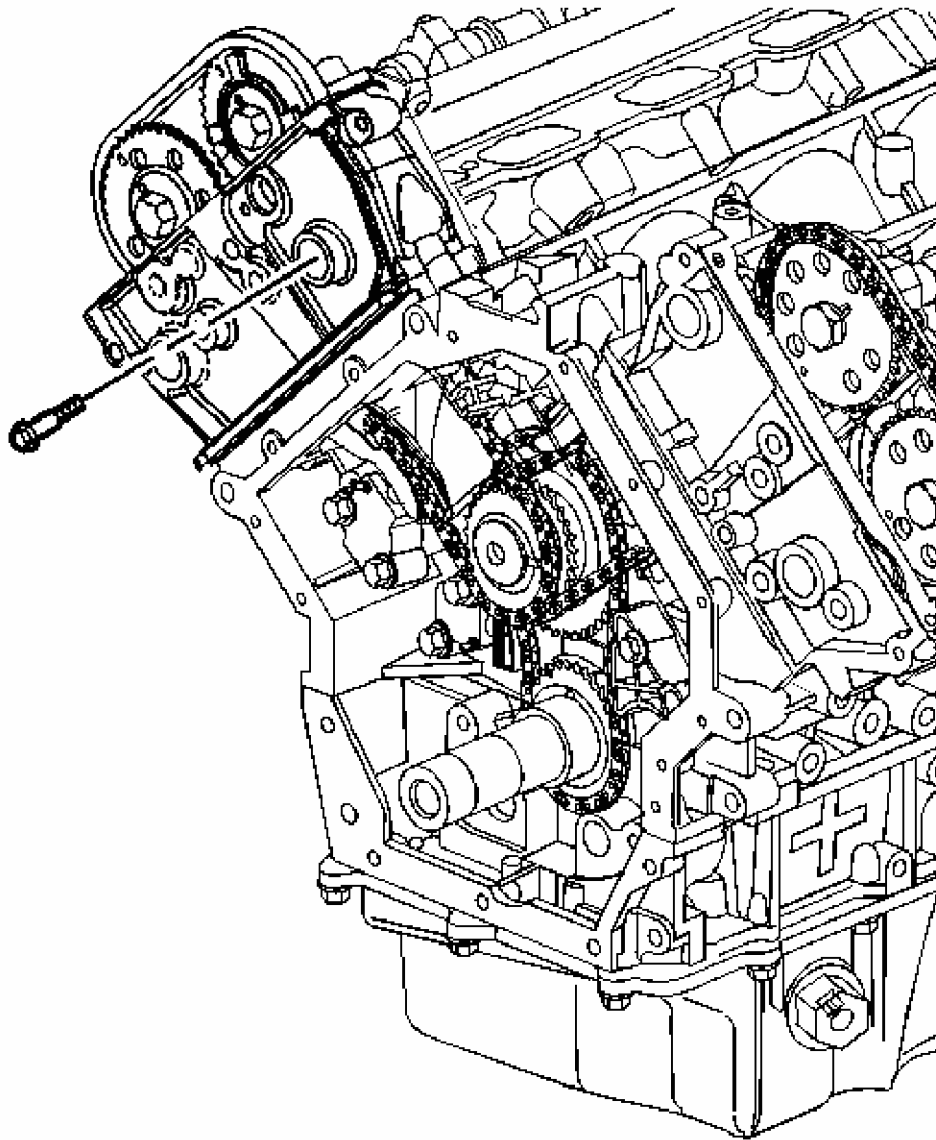


Fig. 270: View Of Upper Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove the upper right secondary camshaft drive chain guide bolt.

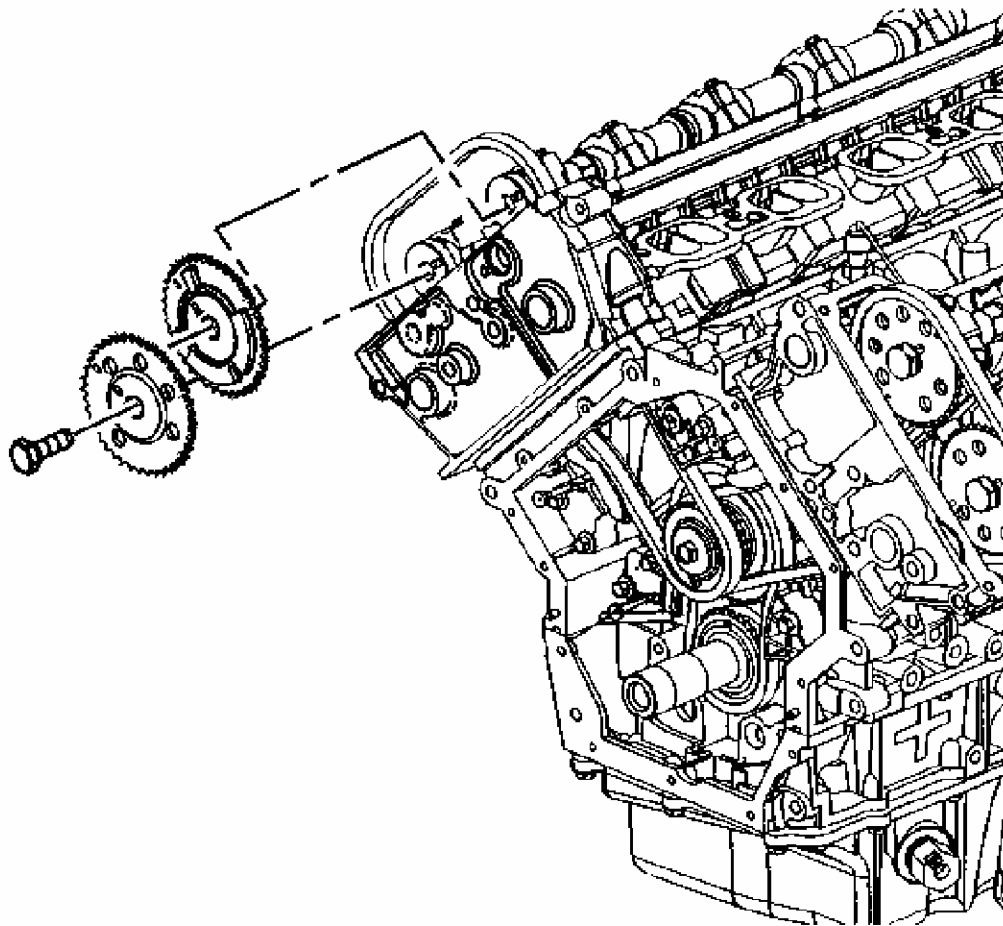


Fig. 271: Identifying Camshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Torque Reaction Against Timing Drive Chain Notice .**

5. Remove the camshaft sprocket bolts from the camshafts. Use an open wrench on the hex cast near the front of each camshaft to prevent engine rotation when loosening the camshaft sprocket bolts.
6. Lift the secondary camshaft drive chain from the camshaft sprocket teeth and slide the camshaft sprockets off of the camshafts.

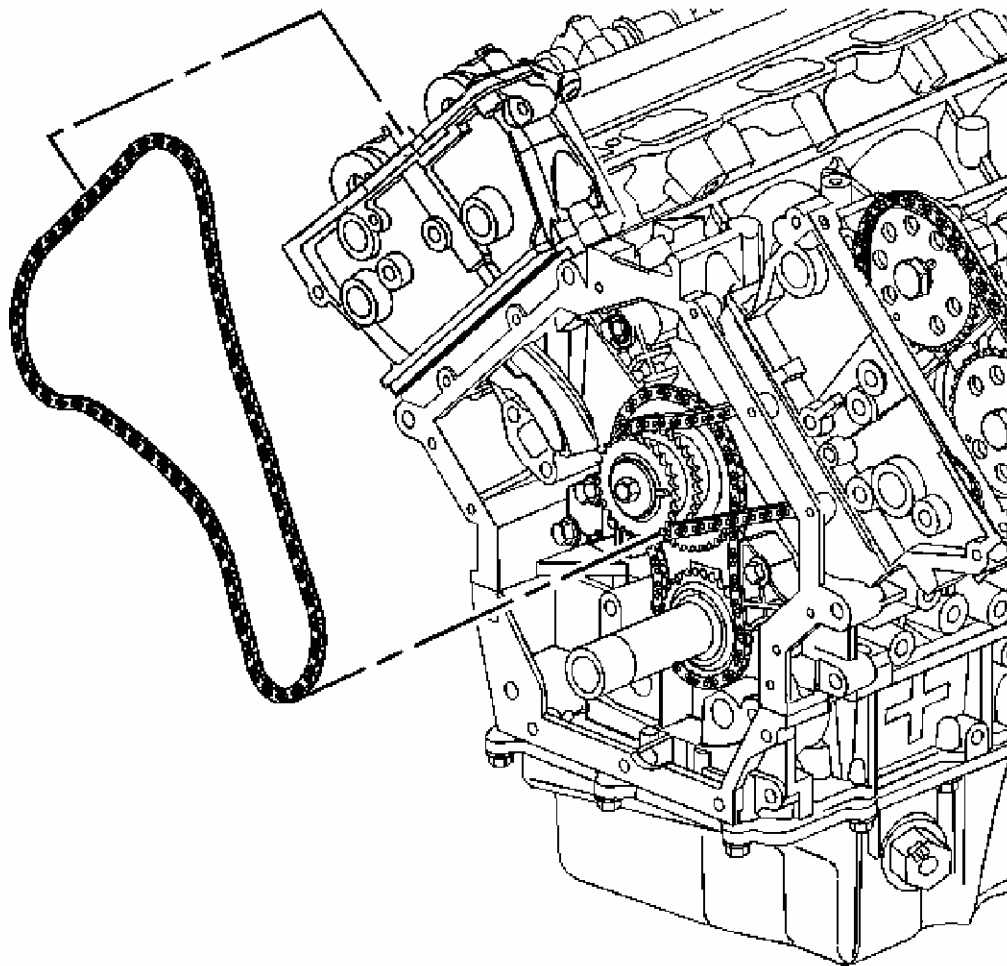


Fig. 272: View of Right Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

7. Remove the right secondary camshaft drive chain.

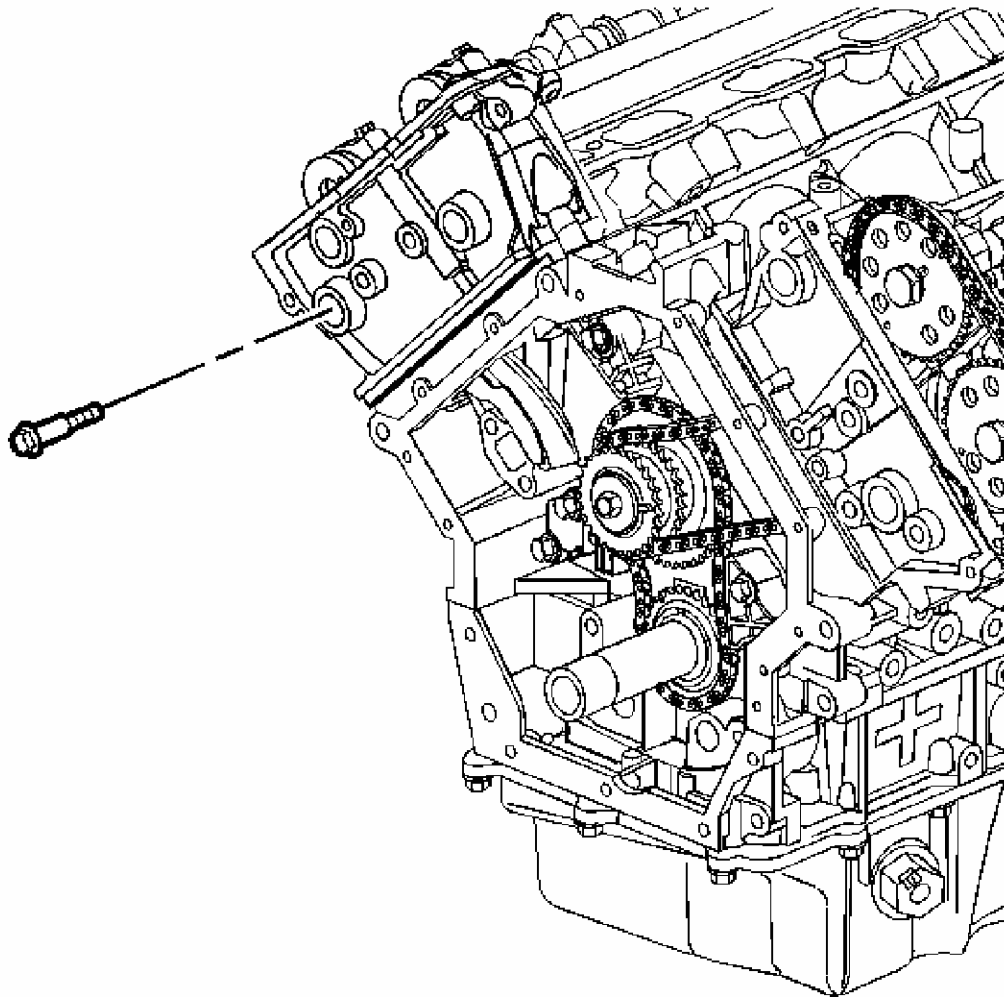


Fig. 273: Identifying Right Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the right secondary camshaft drive chain shoe bolt.

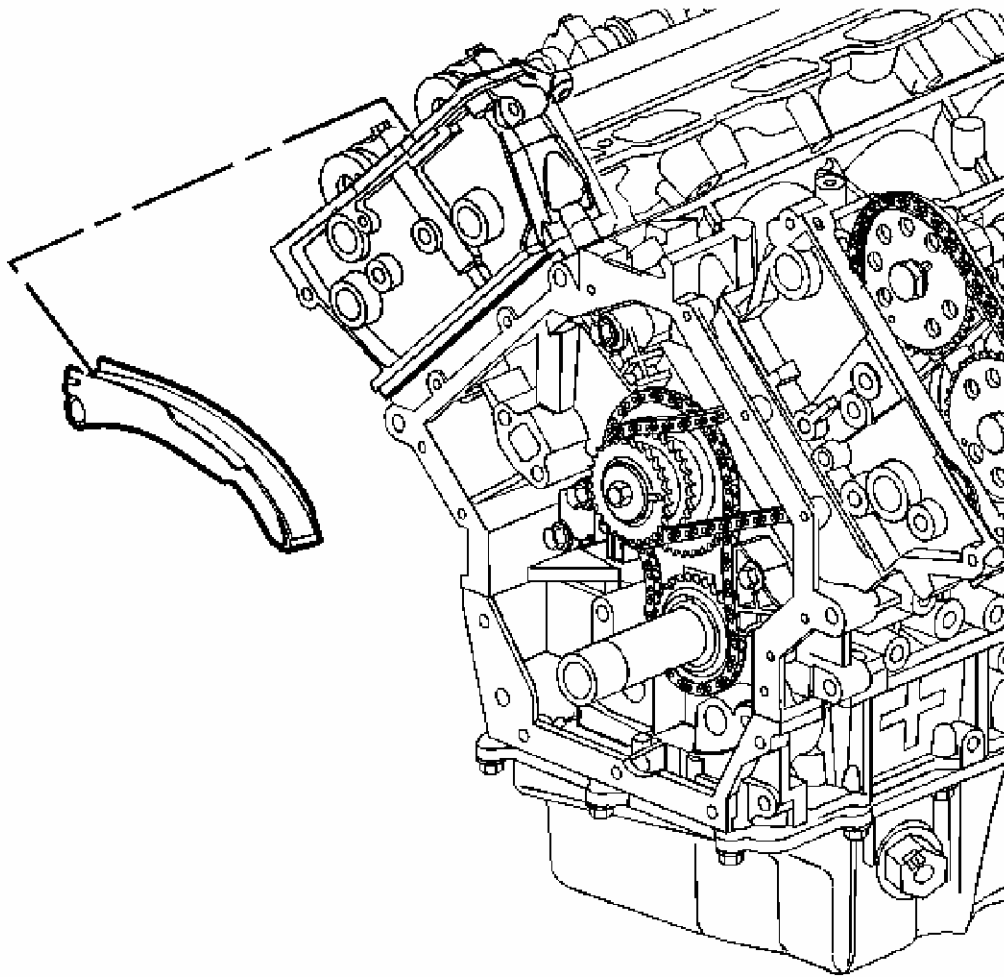


Fig. 274: View of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

9. Remove the right secondary camshaft drive chain shoe.

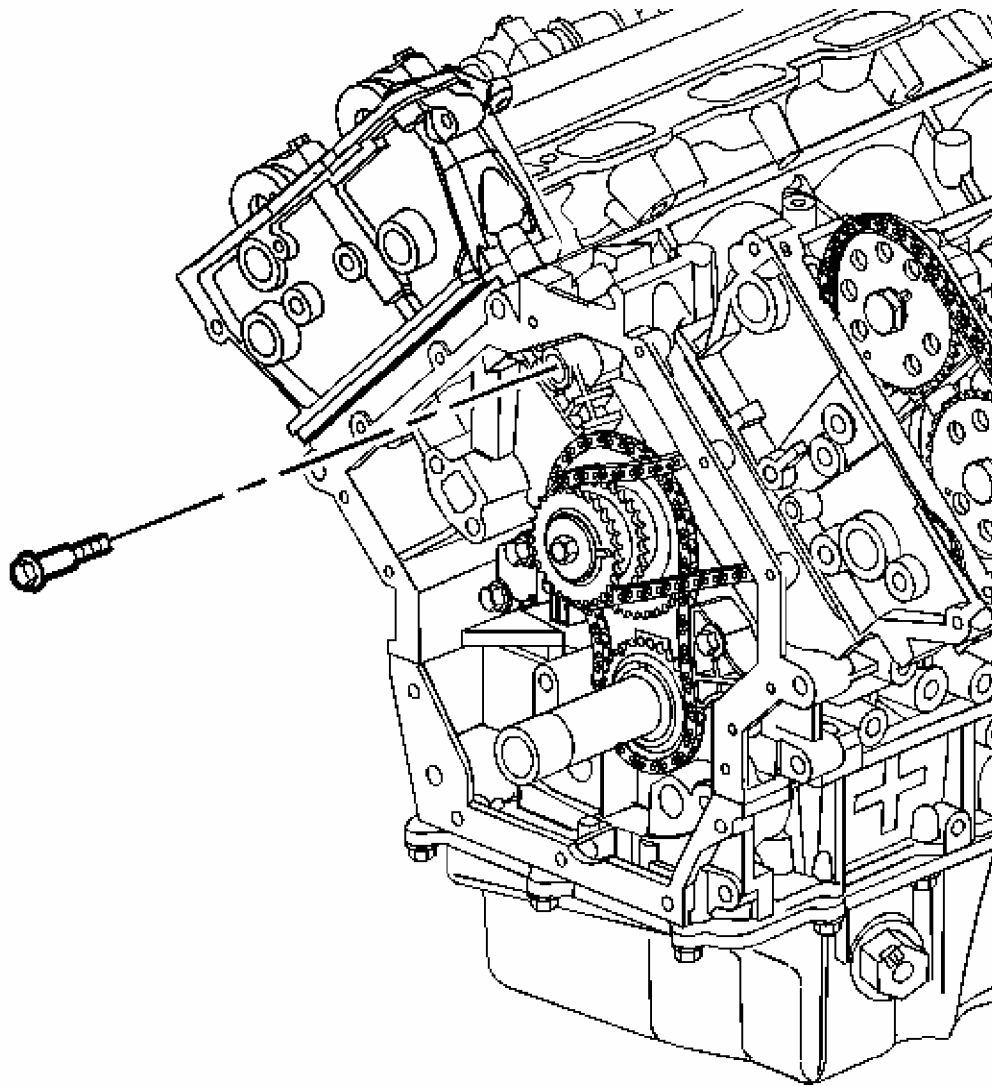


Fig. 275: Identifying Lower Right Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

10. Remove the lower right secondary camshaft drive chain guide bolt.

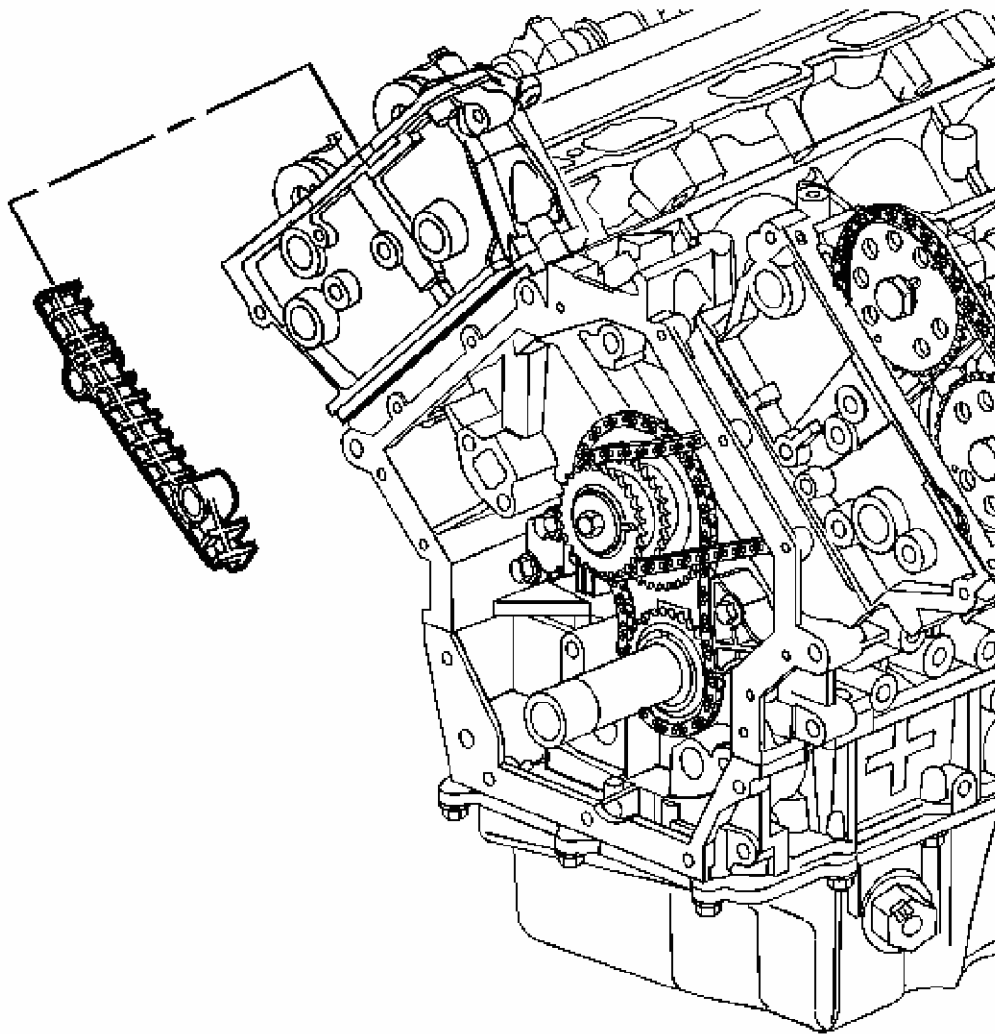


Fig. 276: View of Right Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

11. Remove the right secondary camshaft drive chain guide.

SECONDARY CAMSHAFT DRIVE CHAIN REMOVAL - LEFT SIDE

REMOVAL PROCEDURE

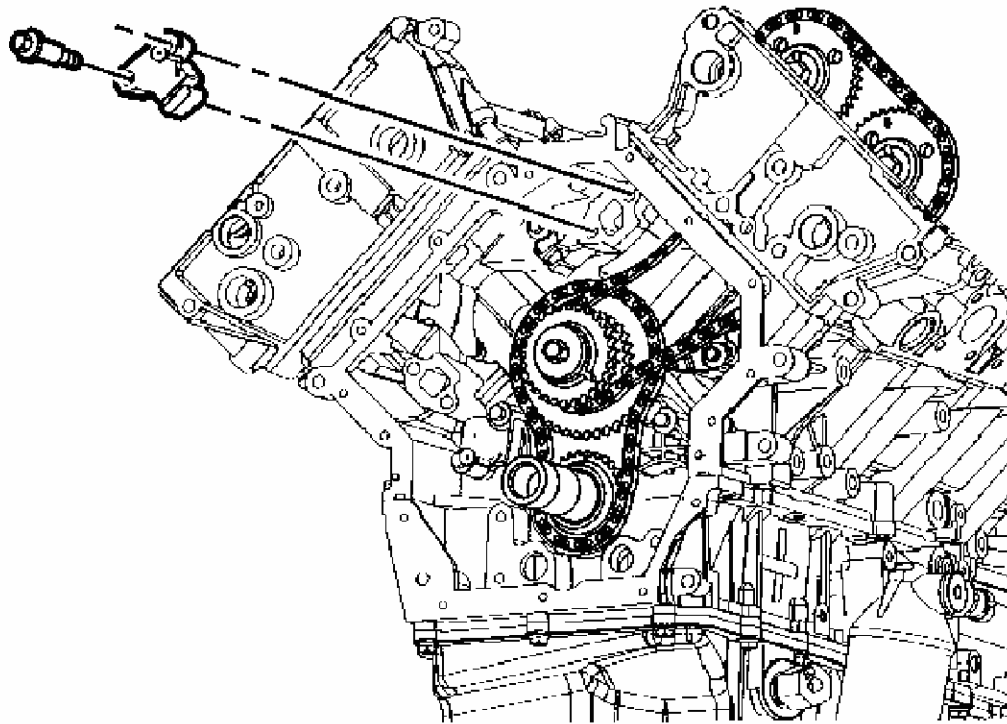


Fig. 277: View Of Left Secondary Camshaft Drive Chain Tensioner Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the left secondary camshaft drive chain tensioner bolts.
2. Remove the left secondary camshaft drive chain tensioner allowing it to expand as you remove it.

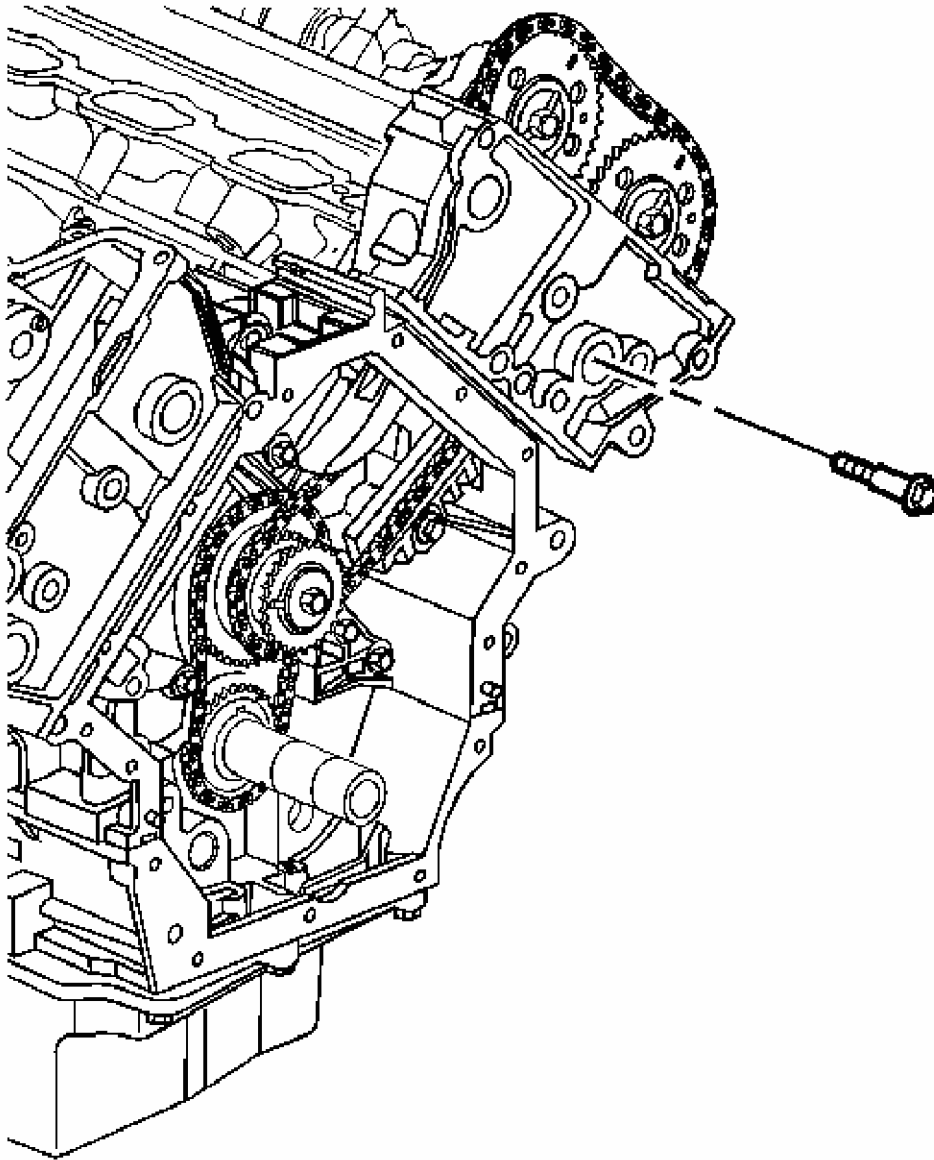


Fig. 278: Identifying Upper Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the upper left secondary camshaft drive chain guide bolt.

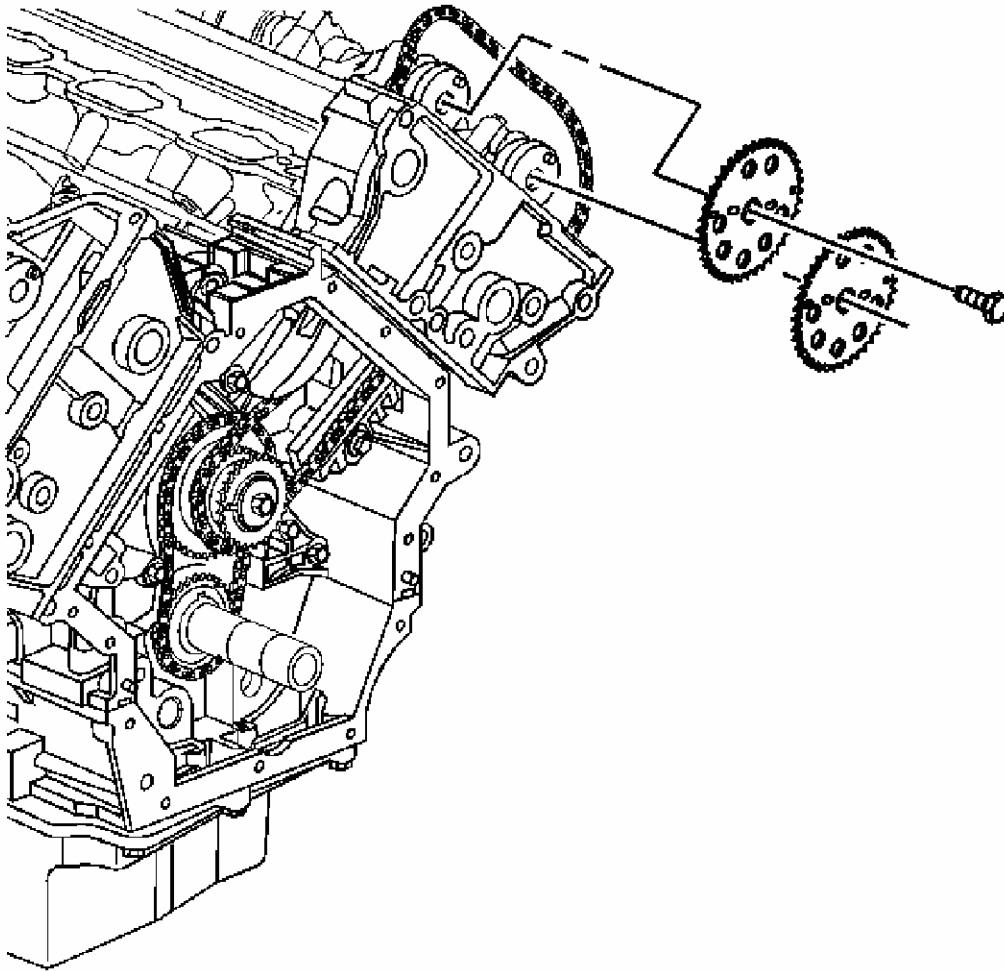


Fig. 279: Securing Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: **Refer to Torque Reaction Against Timing Drive Chain Notice .**

4. Remove the camshaft sprocket bolts from the camshafts. Use an open wrench on the hex cast near the front of each camshaft to prevent engine rotation when loosening the camshaft sprocket bolts.
5. Lift the secondary camshaft drive chain from the camshaft sprocket teeth and slide the camshaft sprockets off of the camshafts.

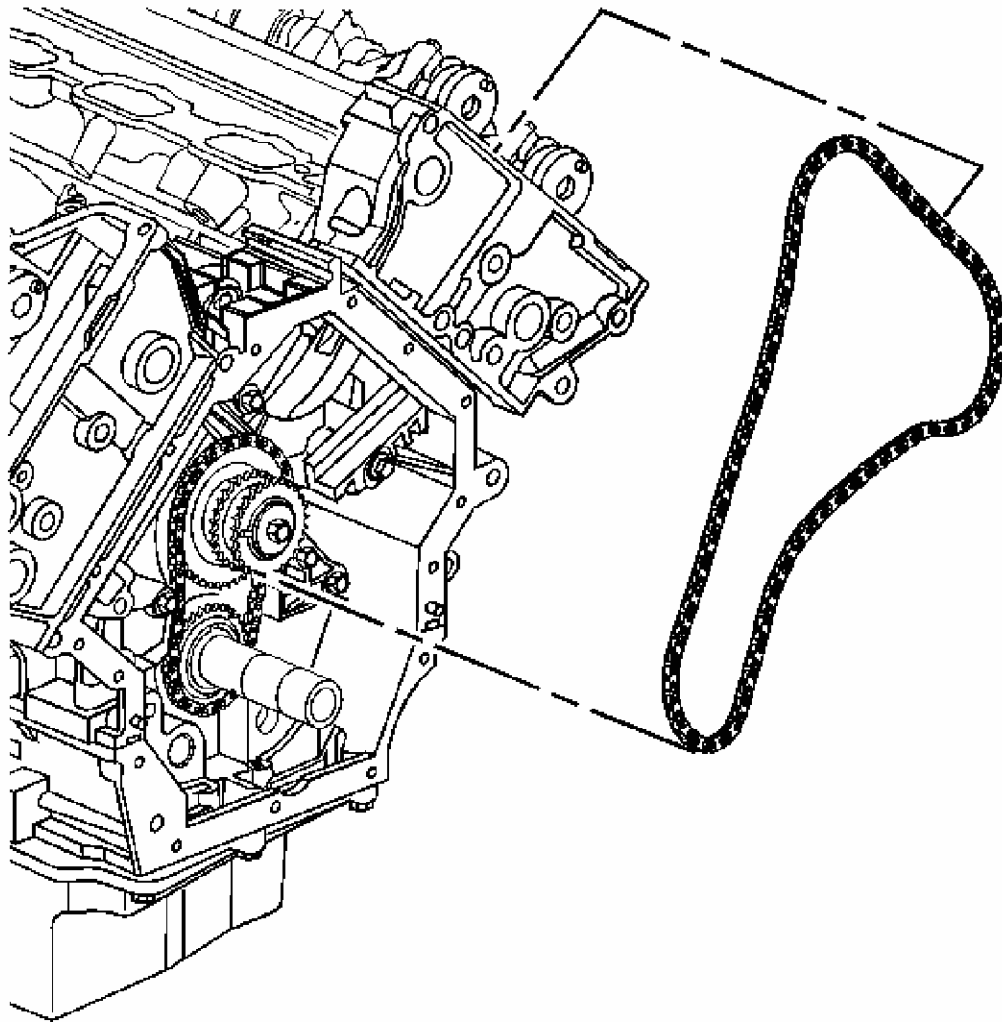


Fig. 280: View of Left Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

6. Remove the left secondary drive chain.

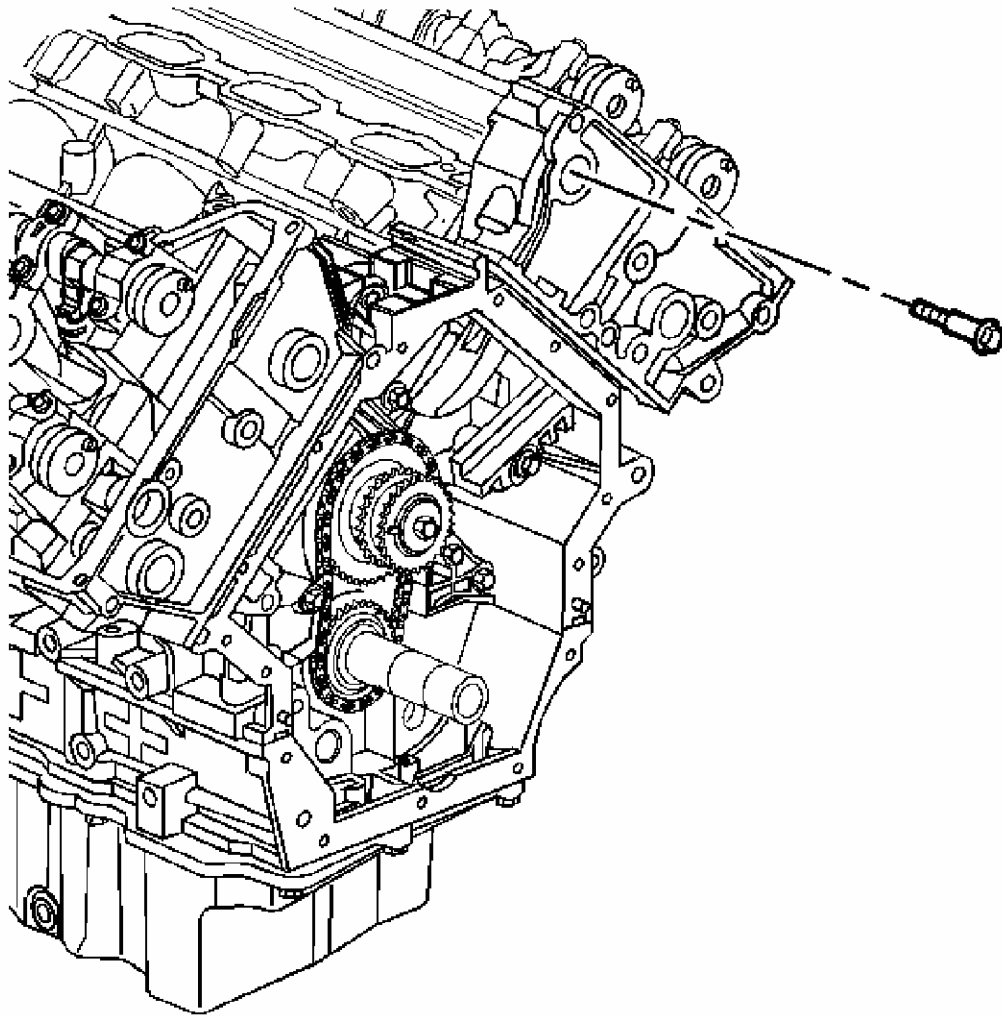


Fig. 281: Identifying Left Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

7. Remove the left secondary camshaft drive chain shoe bolt.

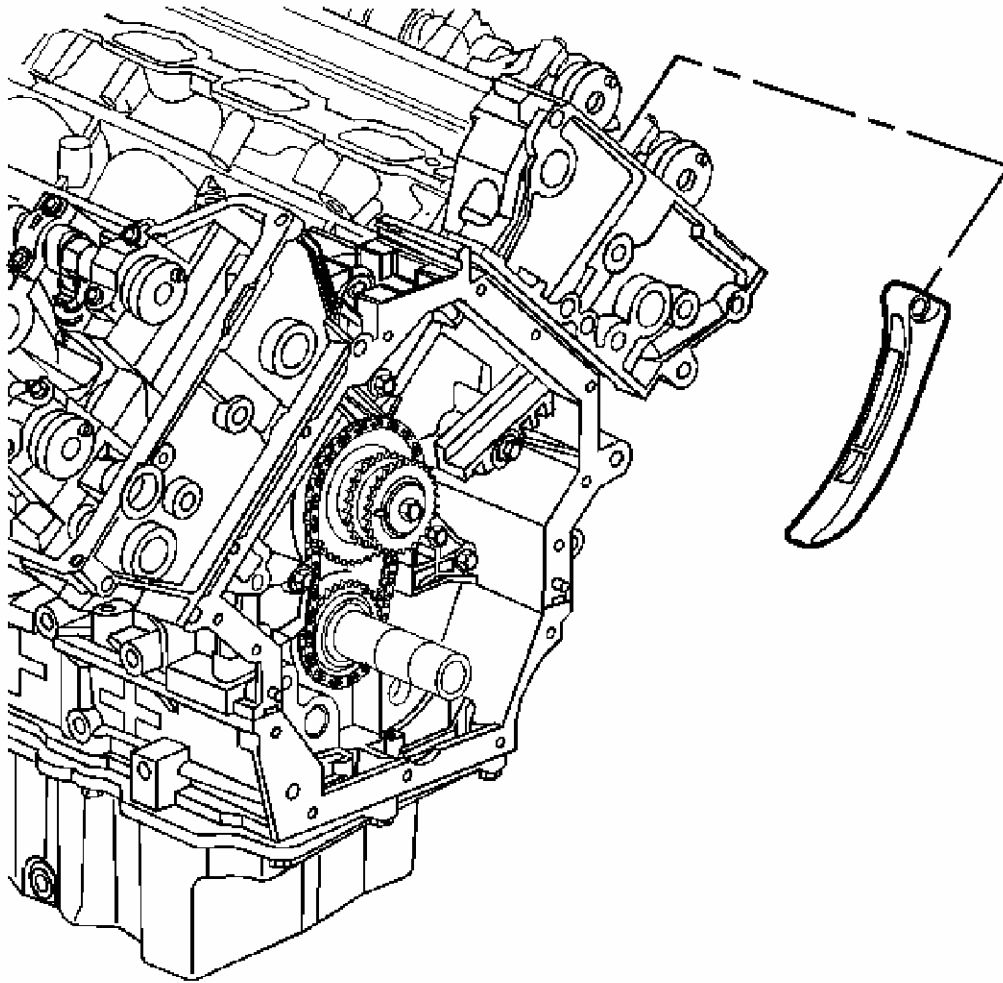


Fig. 282: View of Left Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

8. Remove the left secondary camshaft drive chain shoe.

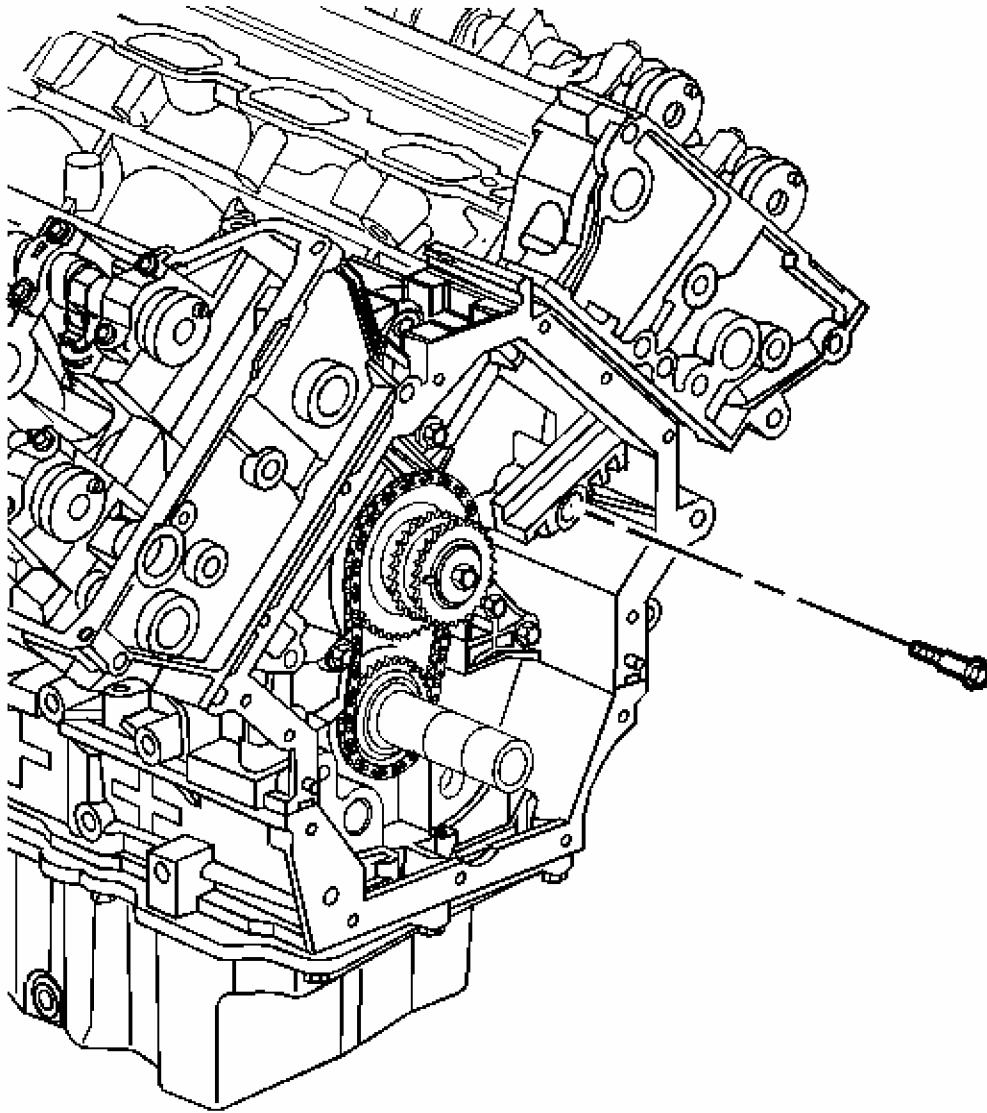


Fig. 283: Identifying Lower Left Secondary Camshaft Drive Chain Guide Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove the lower left secondary camshaft drive chain guide bolt.

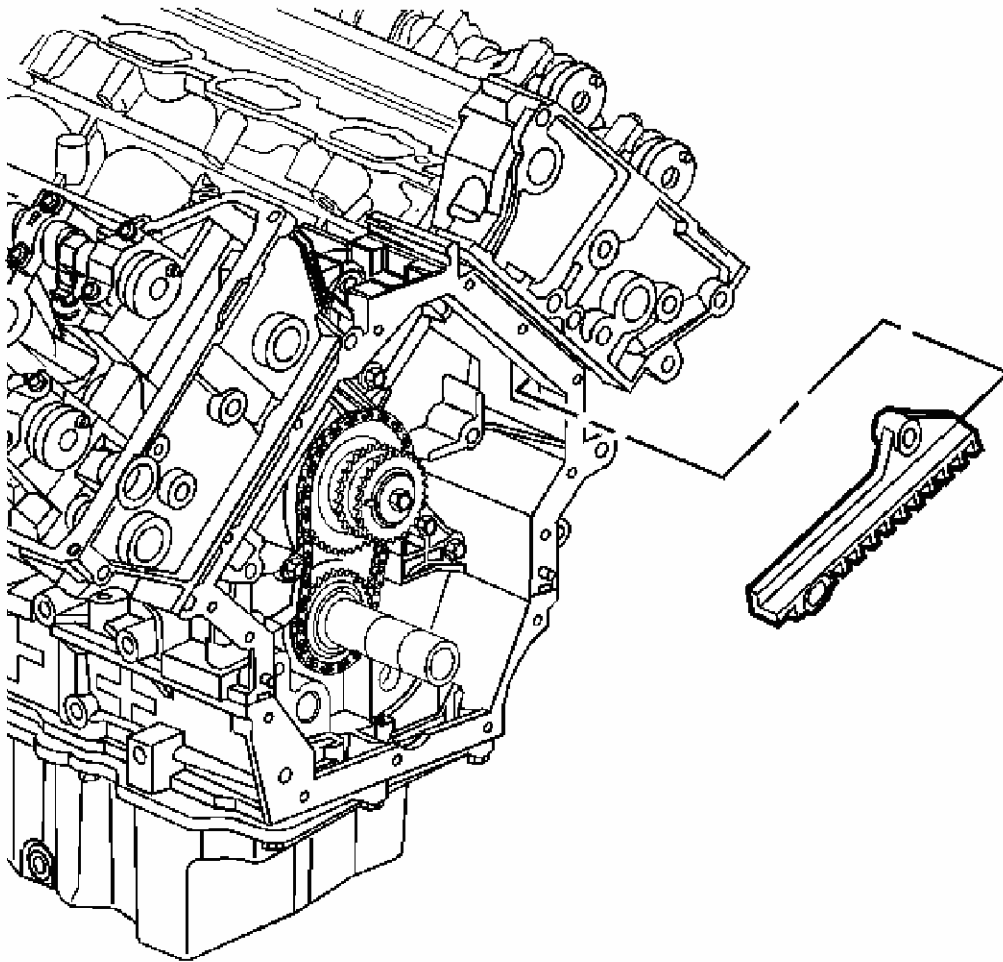


Fig. 284: Left Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

10. Remove the left secondary camshaft drive chain guide.

PRIMARY CAMSHAFT DRIVE CHAIN REMOVAL

REMOVAL PROCEDURE

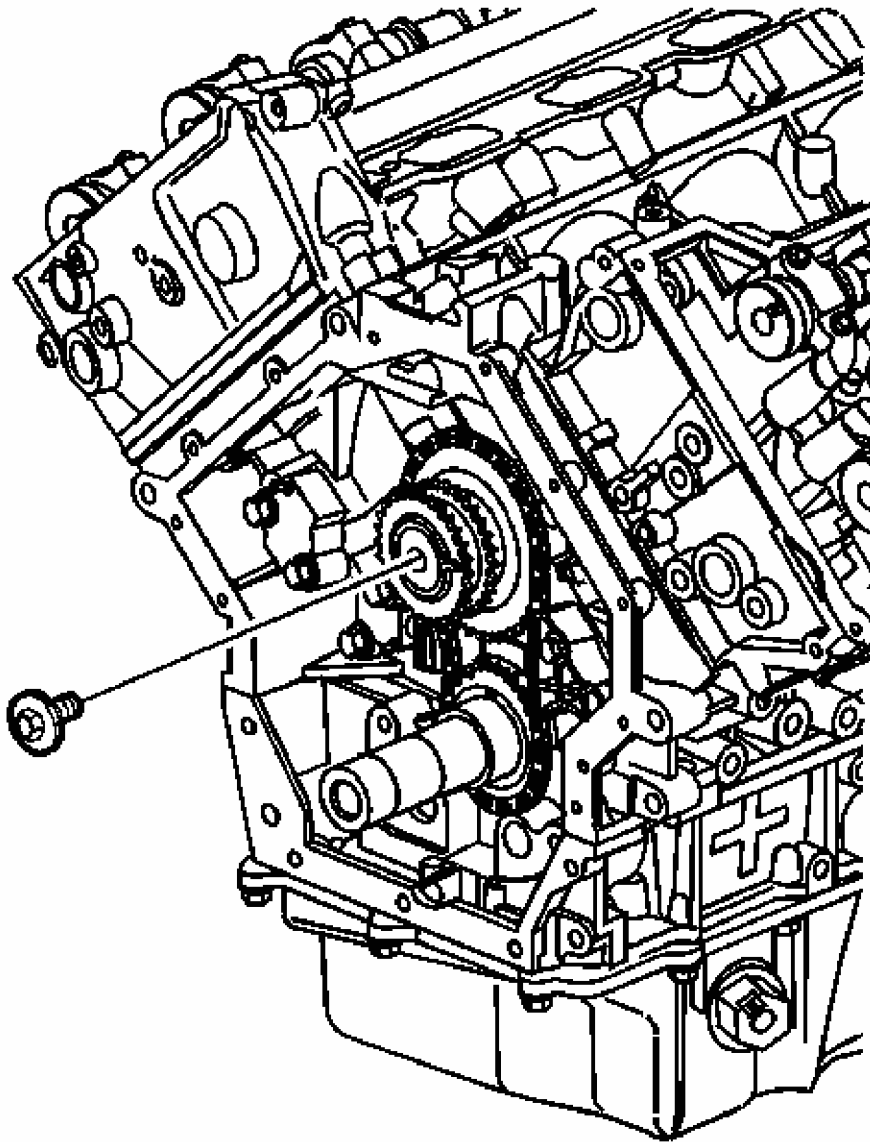


Fig. 285: Identifying Camshaft Intermediate Drive Shaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft intermediate drive shaft sprocket bolt.

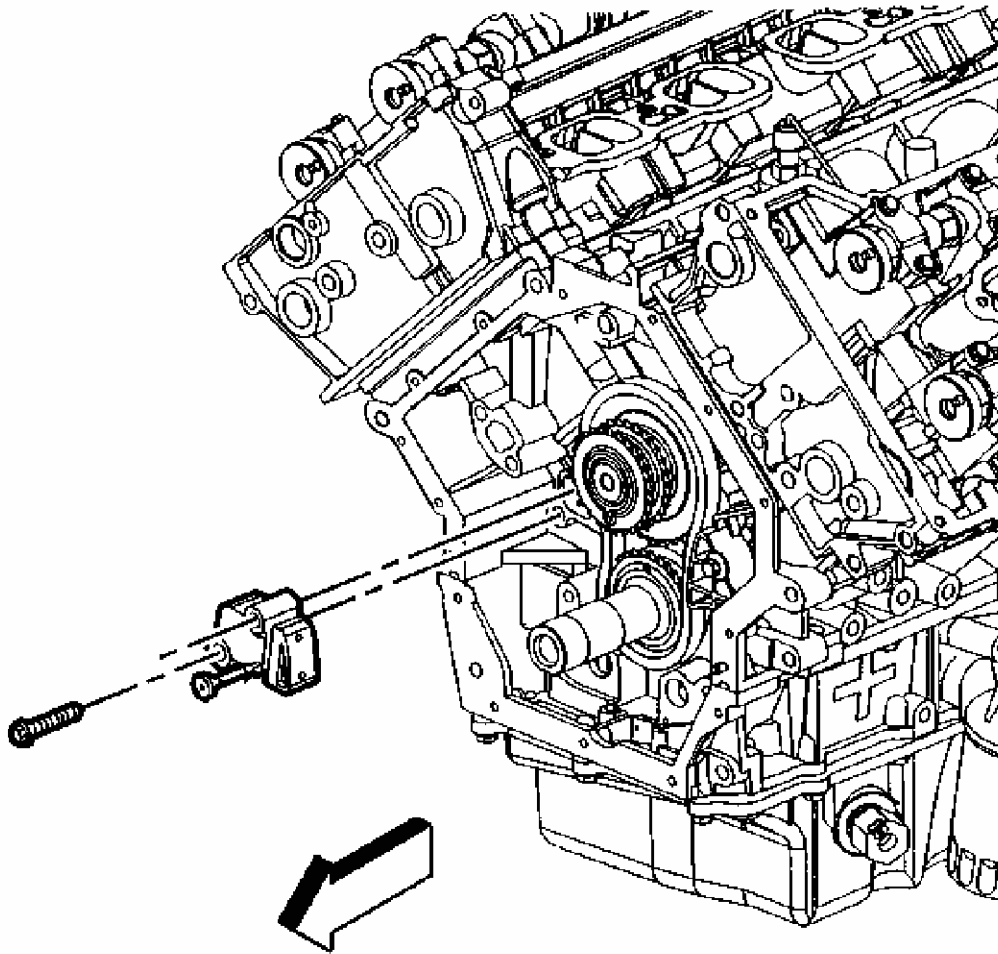


Fig. 286: Identifying Primary Camshaft Drive Chain Tensioner Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the primary camshaft drive chain tensioner bolts.
3. Remove the primary camshaft drive chain tensioner.

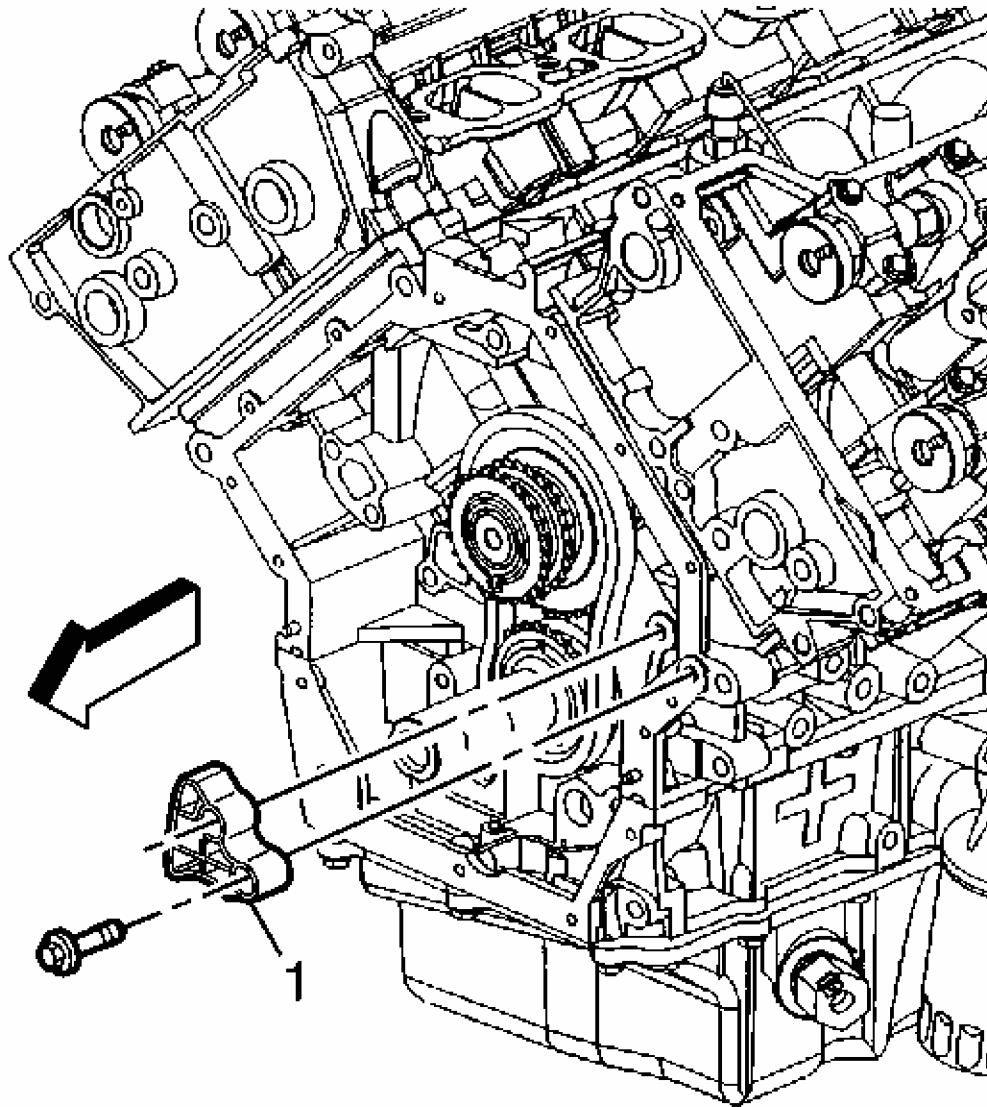


Fig. 287: Locating Primary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the primary camshaft drive chain guide bolts.
5. Remove the primary camshaft drive chain guide (1).

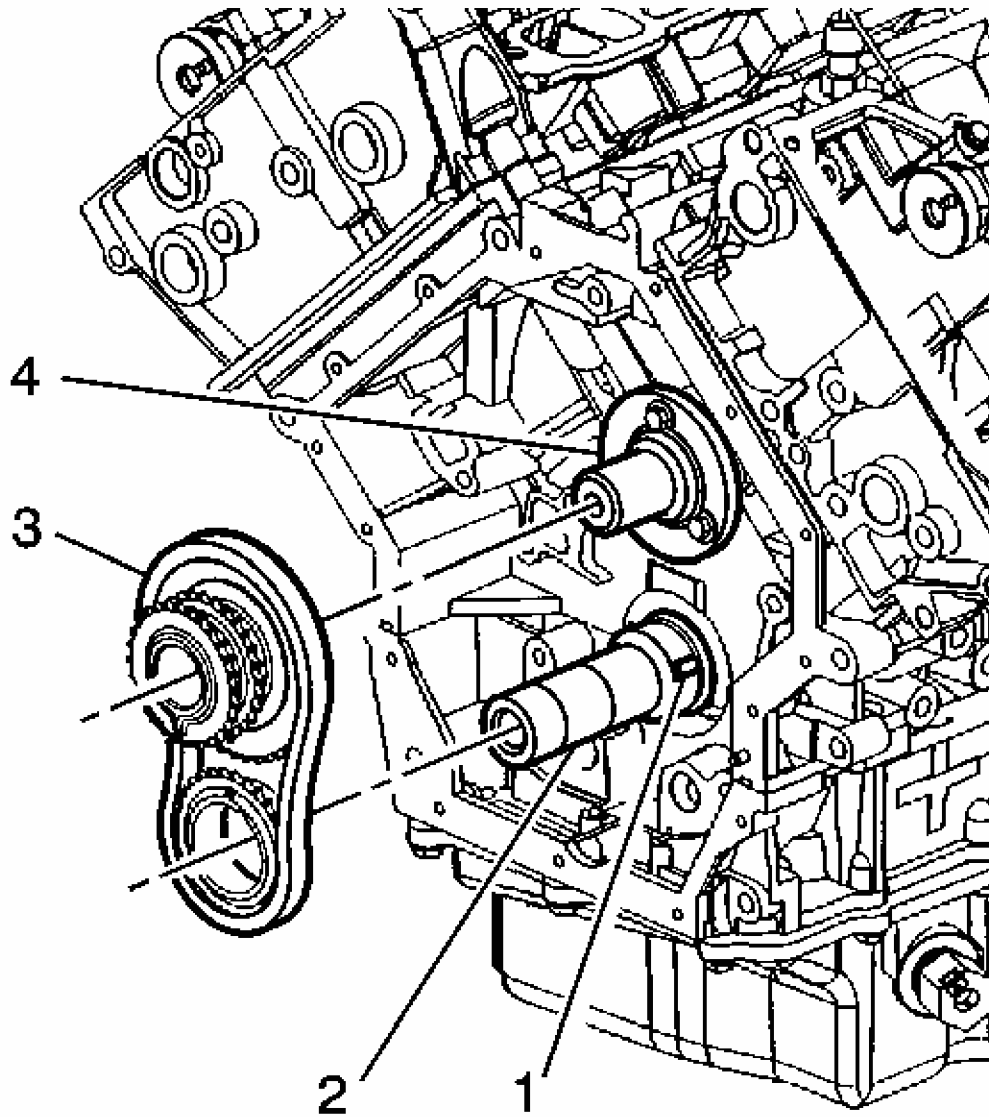


Fig. 288: Identifying Camshaft Intermediate Drive Shaft Sprocket, Primary Camshaft Drive Chain & Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

6. Remove the camshaft intermediate drive shaft sprocket, primary camshaft drive chain and crankshaft sprocket (3) as an assembly.

CAMSHAFT INTERMEDIATE DRIVE SHAFT REMOVAL

REMOVAL PROCEDURE

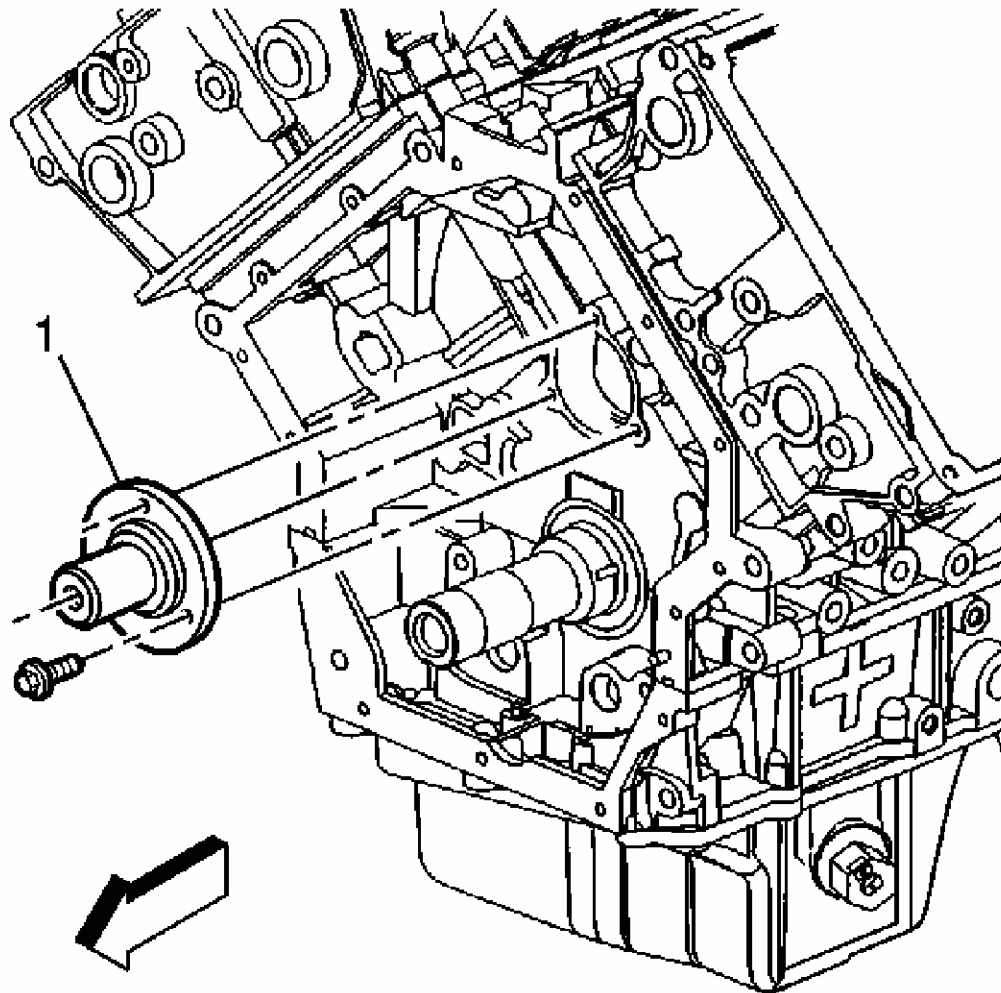


Fig. 289: Identifying Camshaft Intermediate Driveshaft
Courtesy of GENERAL MOTORS CORP.

1. Remove the intermediate sprocket shaft retaining bolts.
2. Remove the intermediate sprocket shaft (1).

EXHAUST CAMSHAFT REMOVAL - LEFT SIDE

REMOVAL PROCEDURE

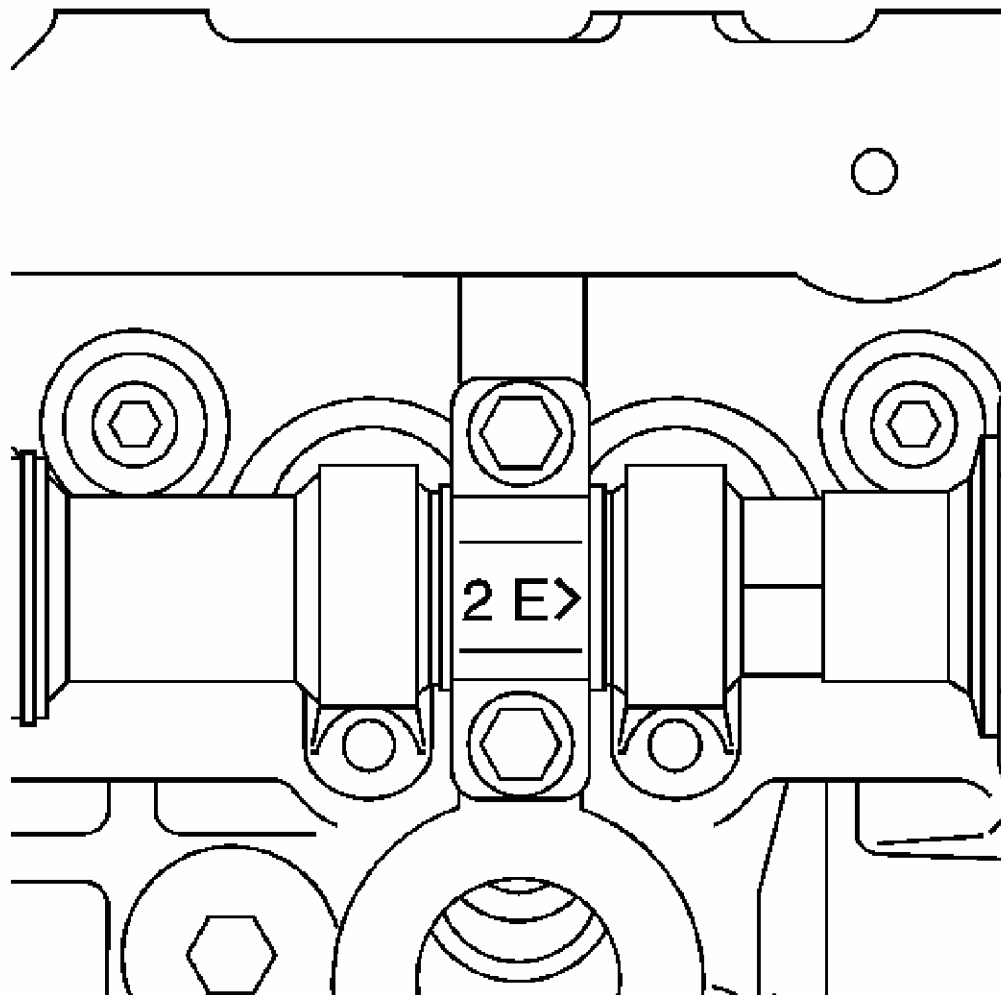


Fig. 290: View Of Exhaust Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Bearing caps must remain with their original cylinder head and in their original location. Do not mix bearing caps.

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The arrow points toward the front of the engine.
 - The "E" indicates the exhaust camshaft.
 - The number indicates the journal position from the front of the engine.

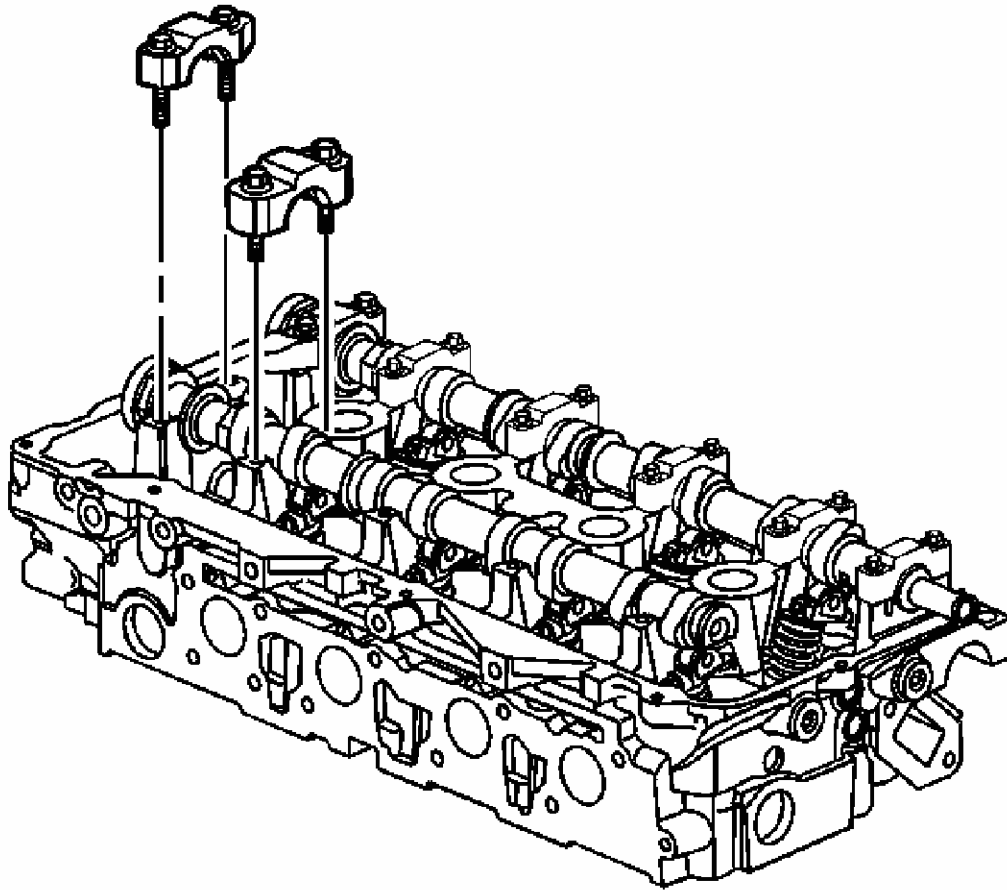


Fig. 291: View Of Left Exhaust Camshaft Bearing Caps & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the left exhaust camshaft bearing cap bolts.
3. Remove the left exhaust camshaft bearing caps. Store the bearing caps in a clean shop towel.

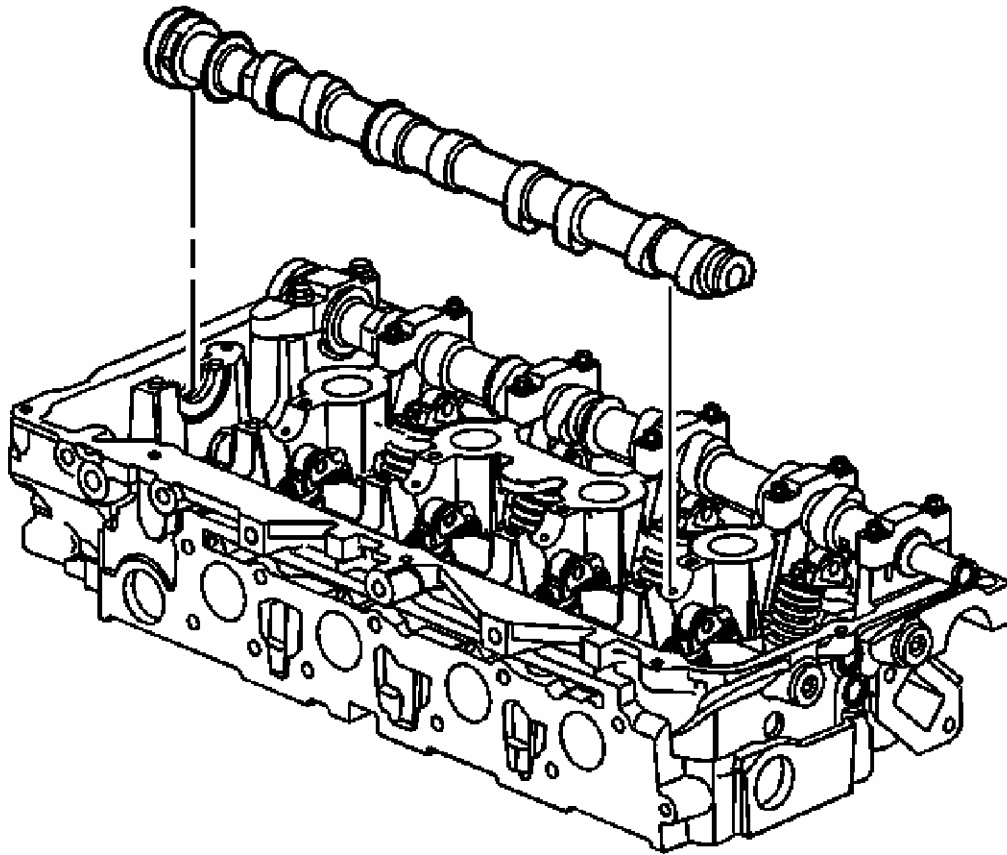


Fig. 292: Identifying Left Exhaust Camshaft
Courtesy of GENERAL MOTORS CORP.

4. Remove the left exhaust camshaft. Place the camshaft in a secure location.
5. Cover the camshaft with an oil soaked towel in order to prevent corrosion.

INTAKE CAMSHAFT REMOVAL - LEFT SIDE

REMOVAL PROCEDURE

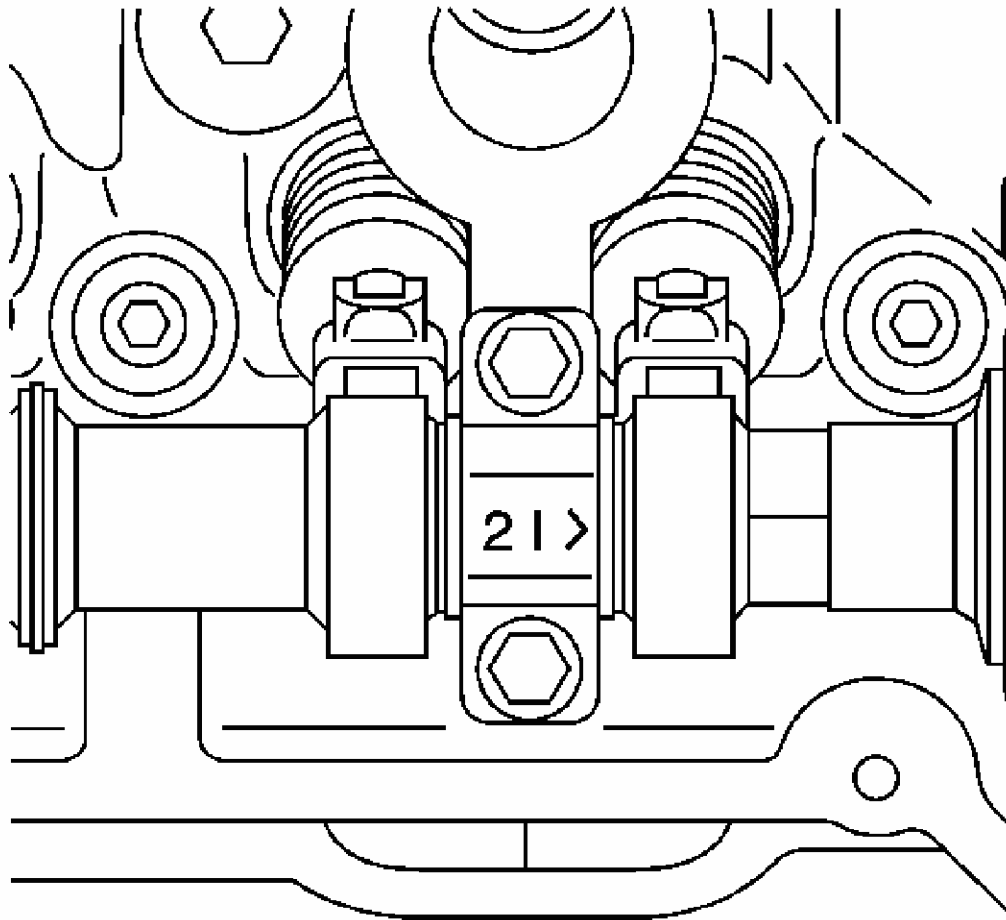


Fig. 293: View Of Intake Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Bearing caps must remain with their original cylinder head and in their original location. Do not mix bearing caps.

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The arrow points toward the front of the engine.
 - The "I" indicates the intake camshaft.
 - The number indicates the journal position from the front of the engine.

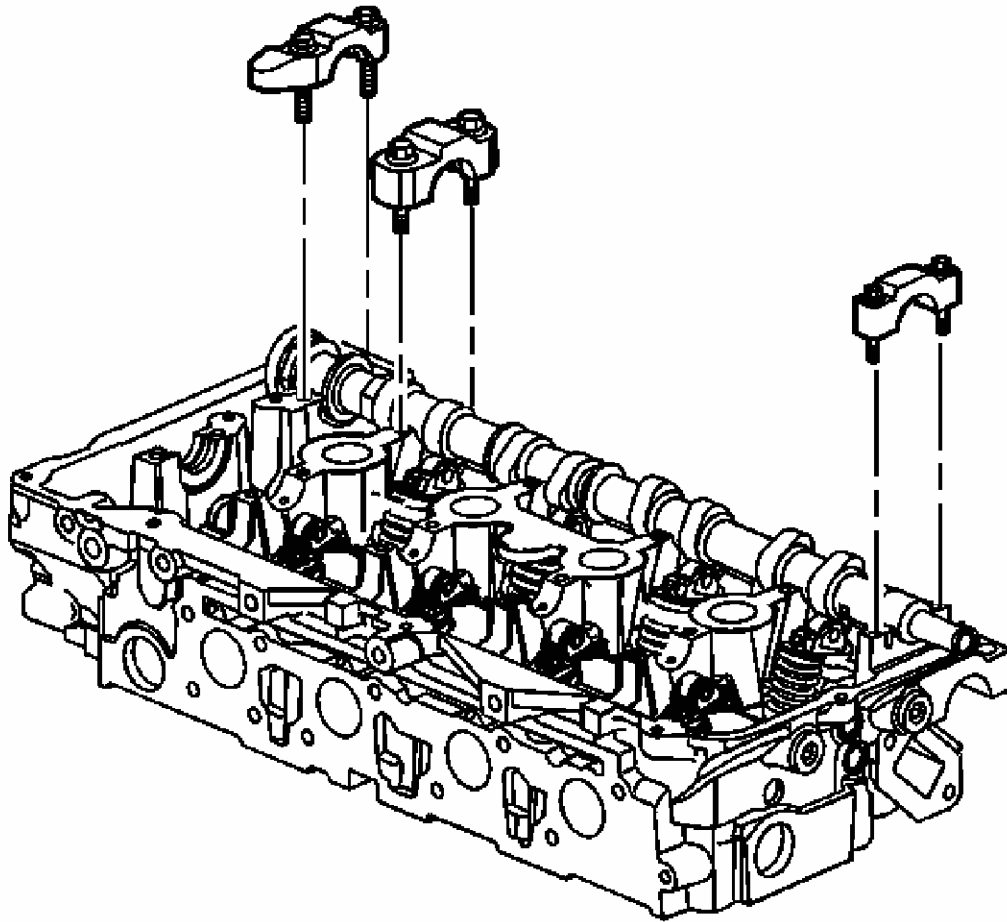


Fig. 294: Locating Left Intake Camshaft Bearing Caps & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the left intake camshaft bearing cap bolts.
3. Remove the left intake camshaft bearing caps. Store the bearing caps in a clean shop towel.

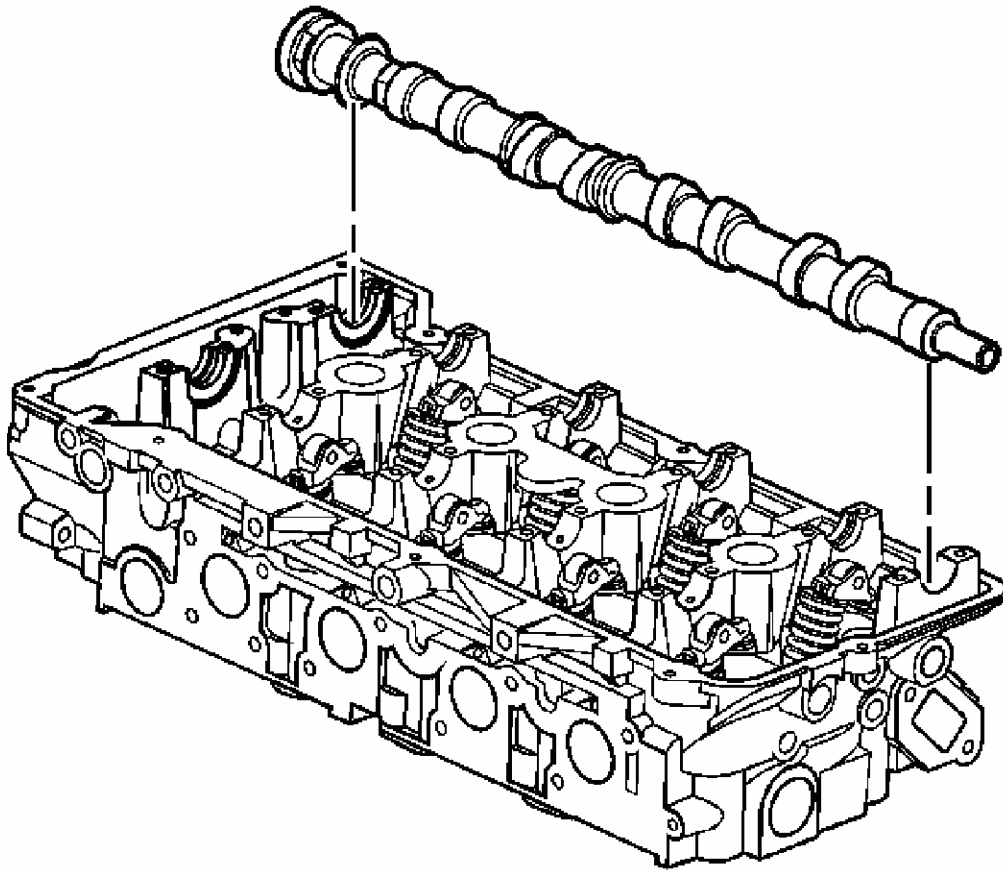


Fig. 295: View Of Left Intake Camshaft
Courtesy of GENERAL MOTORS CORP.

4. Remove the left intake camshaft. Place the camshaft in a secure location.
5. Cover the camshaft with an oil soaked towel in order to prevent corrosion.

EXHAUST CAMSHAFT REMOVAL - RIGHT SIDE

REMOVAL PROCEDURE

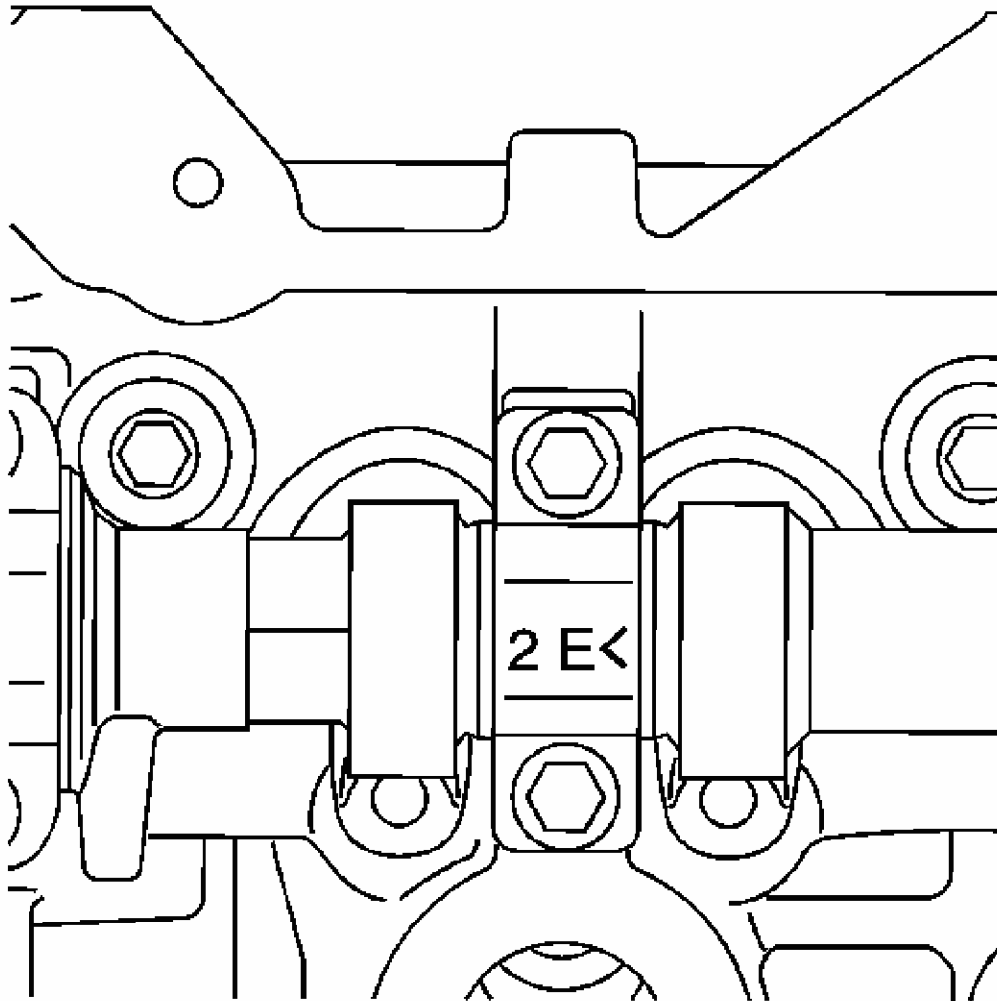


Fig. 296: View Of Exhaust Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Bearing caps must remain with their original cylinder head and in their original location. Do not mix bearing caps.

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The arrow points toward the front of the engine.
 - The "E" indicates the exhaust camshaft.
 - The number indicates the journal position from the front of the engine.

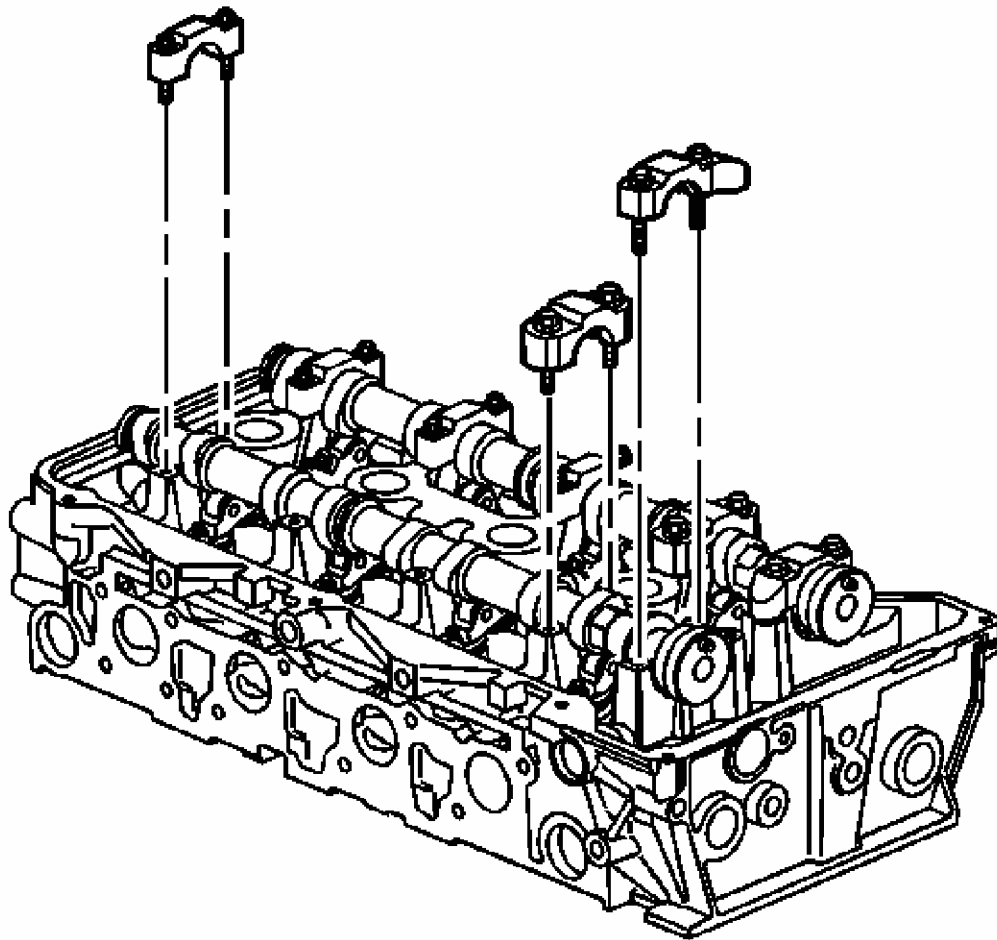


Fig. 297: Locating Right Exhaust Camshaft Bearing Caps & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the right exhaust camshaft bearing cap bolts.
3. Remove the right exhaust camshaft bearing caps. Store the bearing caps in a clean shop towel.

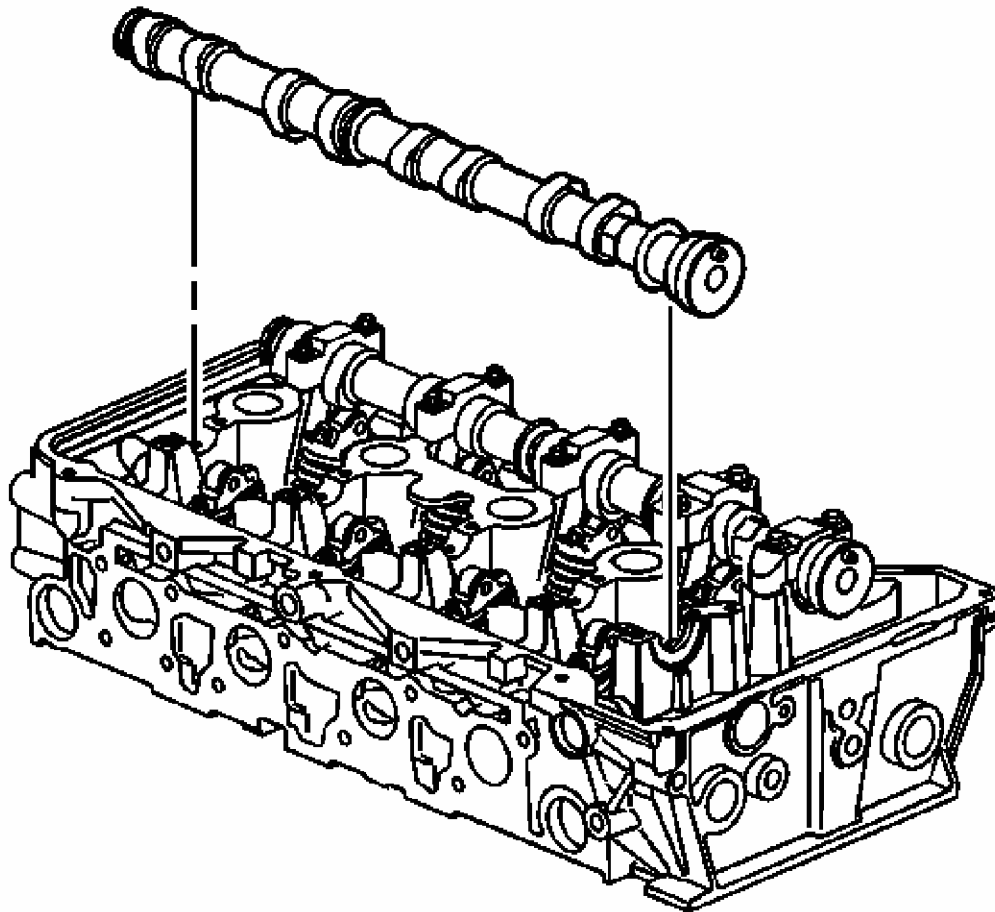


Fig. 298: View Of Right Exhaust Camshaft
Courtesy of GENERAL MOTORS CORP.

4. Remove the right exhaust camshaft. Place the camshaft in a secure location.
5. Cover the camshaft with an oil soaked towel in order to prevent corrosion.

INTAKE CAMSHAFT REMOVAL - RIGHT SIDE

REMOVAL PROCEDURE

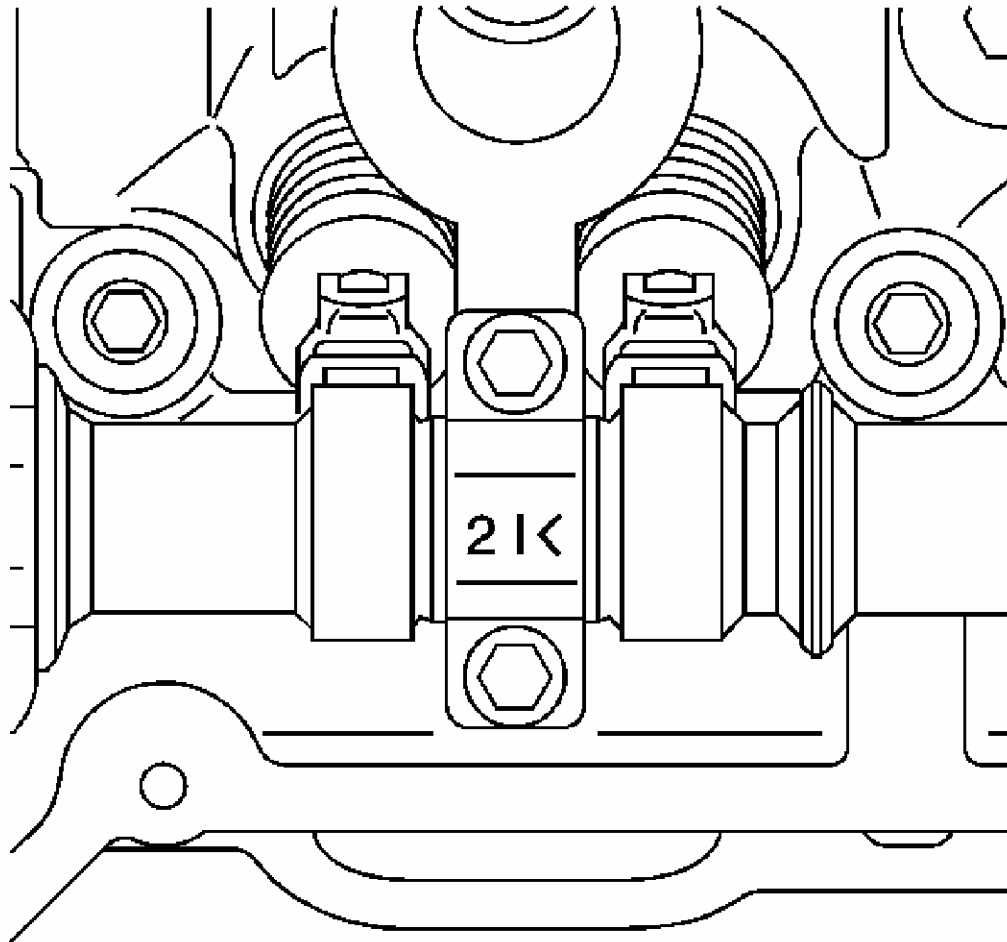


Fig. 299: View Of Intake Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Bearing caps must remain with their original cylinder head and in their original location. Do not mix bearing caps.

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
 - The arrow points toward the front of the engine.
 - The "I" indicates the intake camshaft.
 - The number indicates the journal position from the front of the engine.

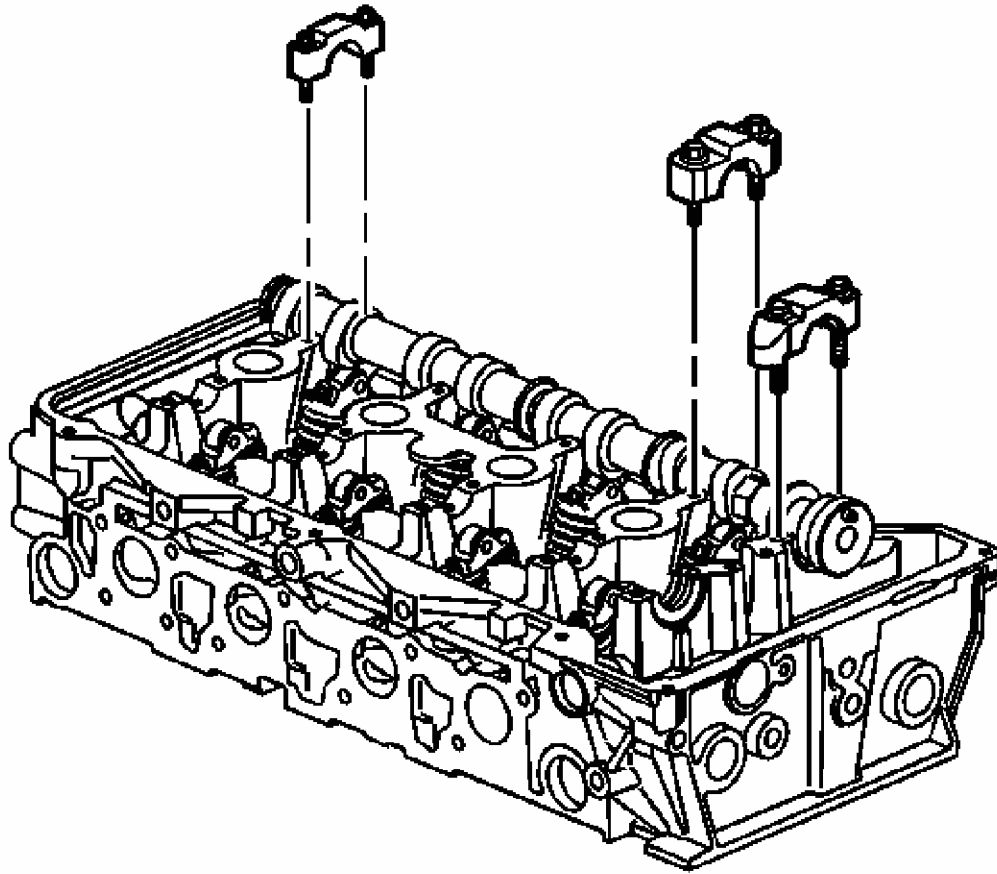


Fig. 300: View Of Right Intake Camshaft Bearing Caps & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the right intake camshaft bearing cap bolts.
3. Remove the right intake camshaft bearing caps. Store the bearing caps in a clean shop towel.

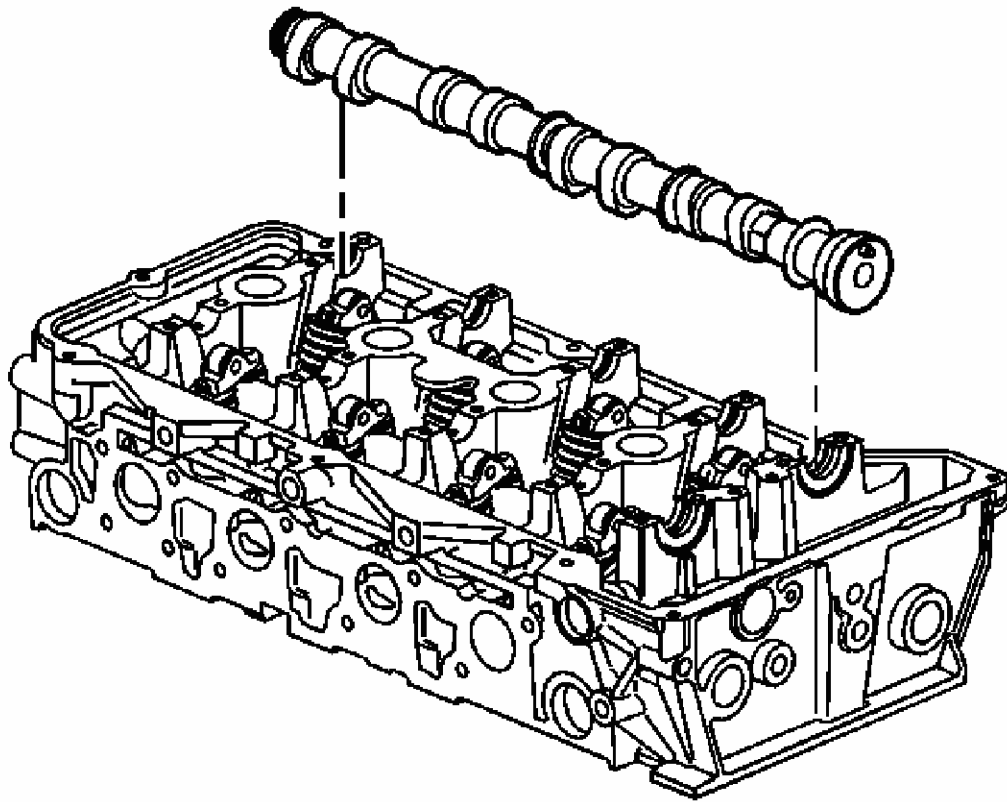


Fig. 301: View Of Right Intake Camshaft
Courtesy of GENERAL MOTORS CORP.

4. Remove the right intake camshaft. Place the camshaft in a secure location.
5. Cover the camshaft with an oil soaked towel in order to prevent corrosion.

VALVE ROCKER ARM REMOVAL - LEFT SIDE

REMOVAL PROCEDURE

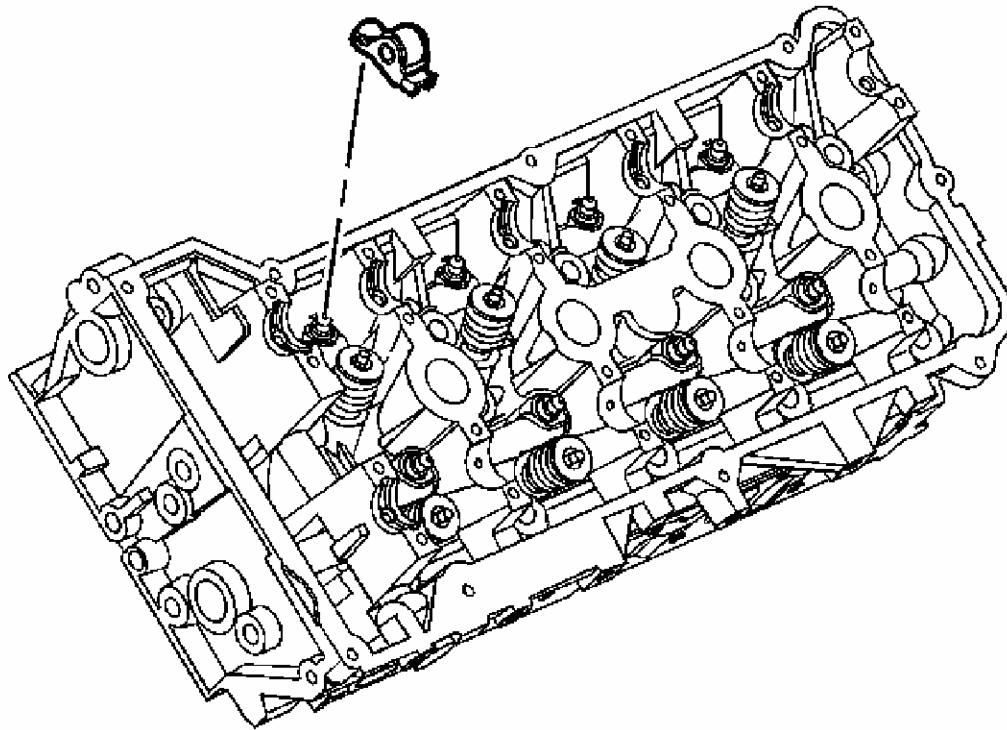


Fig. 302: Identifying Camshaft Followers
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure each camshaft follower remains matched to the original stationary hydraulic lash adjuster (SHLAs) and original location the components were assembled in.

1. Remove the camshaft followers from the left cylinder head.
2. Store the camshafts, followers and SHLAs in a clean, secure location.

VALVE ROCKER ARM REMOVAL - RIGHT SIDE

REMOVAL PROCEDURE

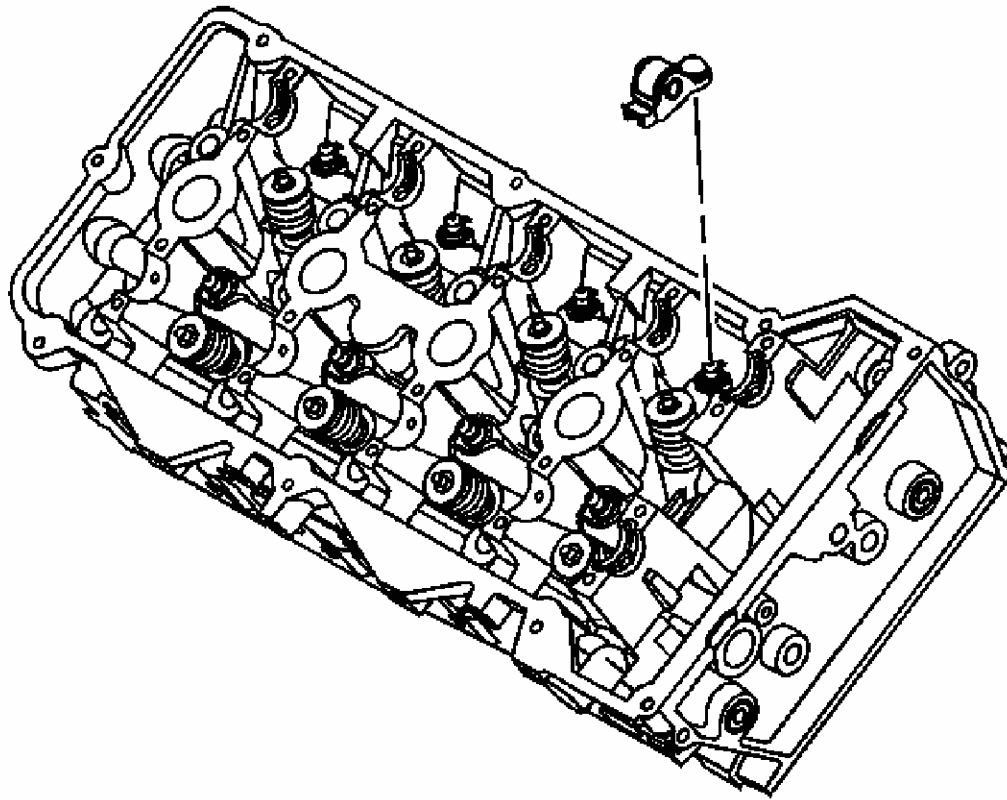


Fig. 303: View Of Camshaft Followers
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure each camshaft follower remains matched to the original stationary hydraulic lash adjuster (SHLAs) and original location the components were assembled in.

1. Remove the camshaft followers from the right cylinder head.
2. Store the camshafts, followers and SHLAs in a clean, secure location.

VALVE LIFTER REMOVAL - LEFT SIDE

REMOVAL PROCEDURE

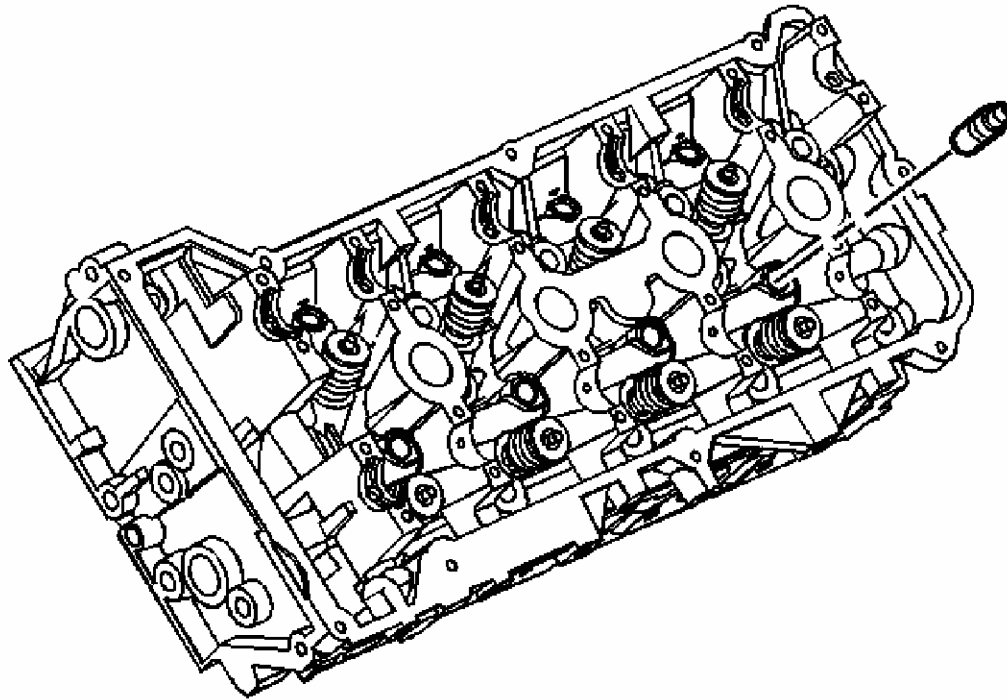


Fig. 304: Locating Left Stationary Hydraulic Lash Adjusters (SHLA)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to VALVE LIFTER PRIMING NOTICE .

IMPORTANT: Ensure each camshaft follower remains matched to the original stationary hydraulic lash adjuster (SHLAs) and original location the components were assembled in.

1. Remove the stationary hydraulic lash adjuster (SHLAs) from the left cylinder head lifter bores.
2. Store the camshafts, followers and SHLAs in a clean, secure location.

VALVE LIFTER REMOVAL - RIGHT SIDE

REMOVAL PROCEDURE

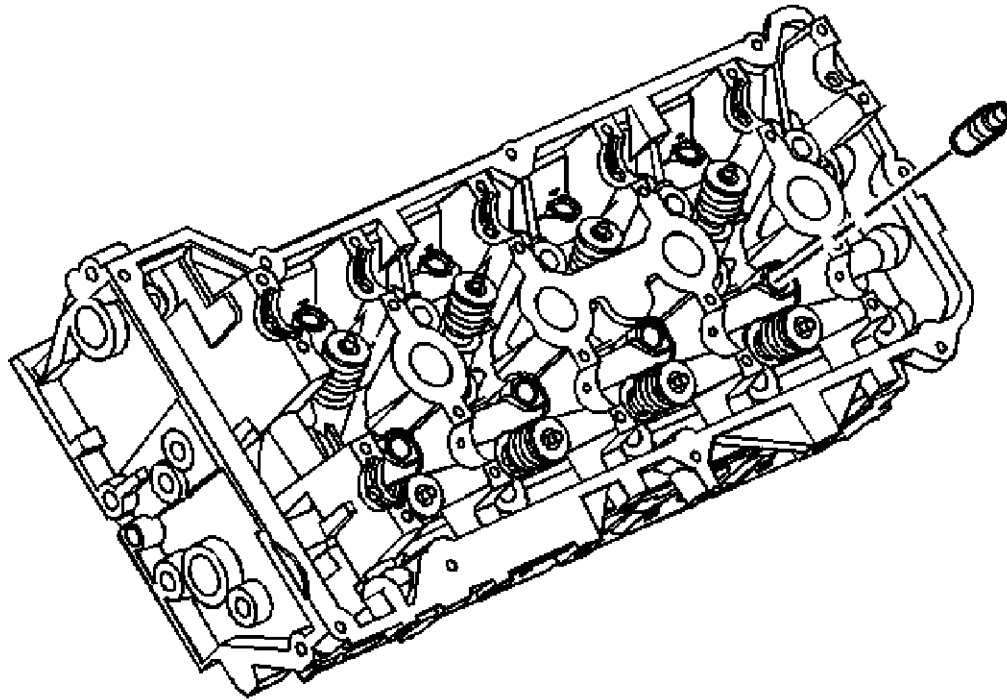


Fig. 305: Locating Left Stationary Hydraulic Lash Adjusters (SHLA)
Courtesy of GENERAL MOTORS CORP.

NOTE: Refer to VALVE LIFTER PRIMING NOTICE .

IMPORTANT: Ensure each camshaft follower remains matched to the original stationary hydraulic lash adjuster (SHLAs) and original location the components were assembled in.

1. Remove the stationary hydraulic lash adjuster (SHLAs) from the right cylinder head lifter bores.
2. Store the camshafts, followers and SHLAs in a clean, secure location.

CYLINDER HEAD REMOVAL - LEFT SIDE

TOOLS REQUIRED

J 28410 Gasket Remover. See Special Tools .

REMOVAL PROCEDURE

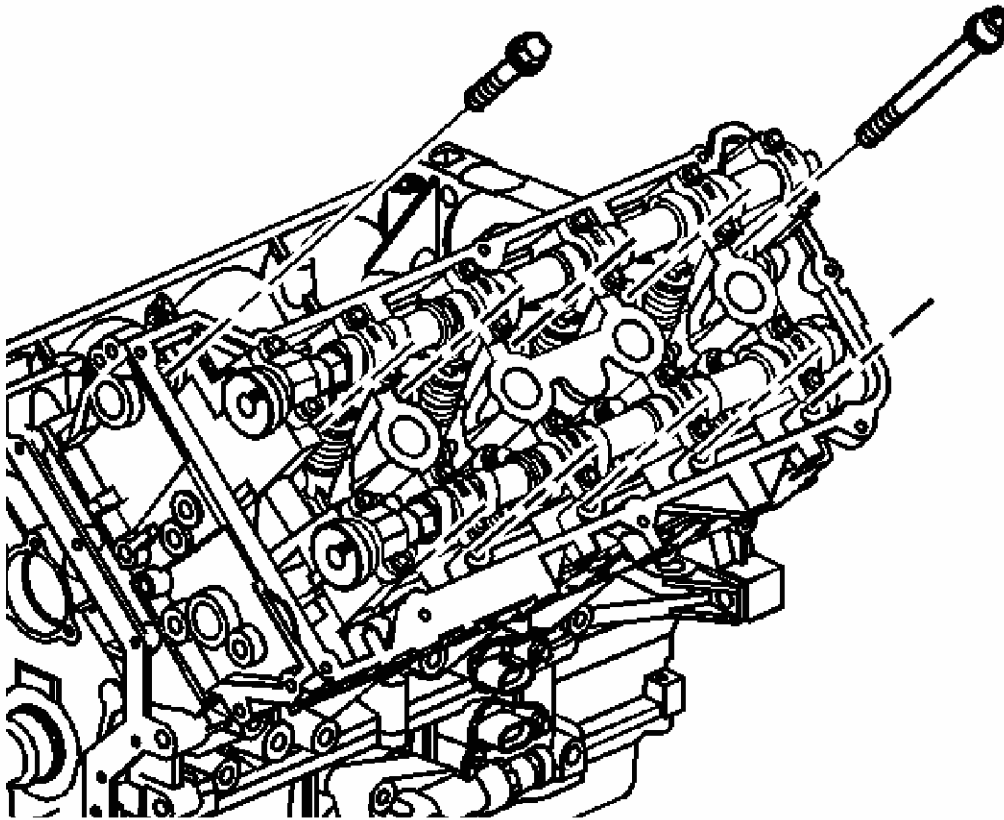


Fig. 306: Identifying Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the 3 M6 external drive bolts from the front portion of the cylinder head.

IMPORTANT: DO NOT reuse the M11 cylinder head bolts.

2. Remove and discard the 10 M11 internal drive cylinder head bolts.

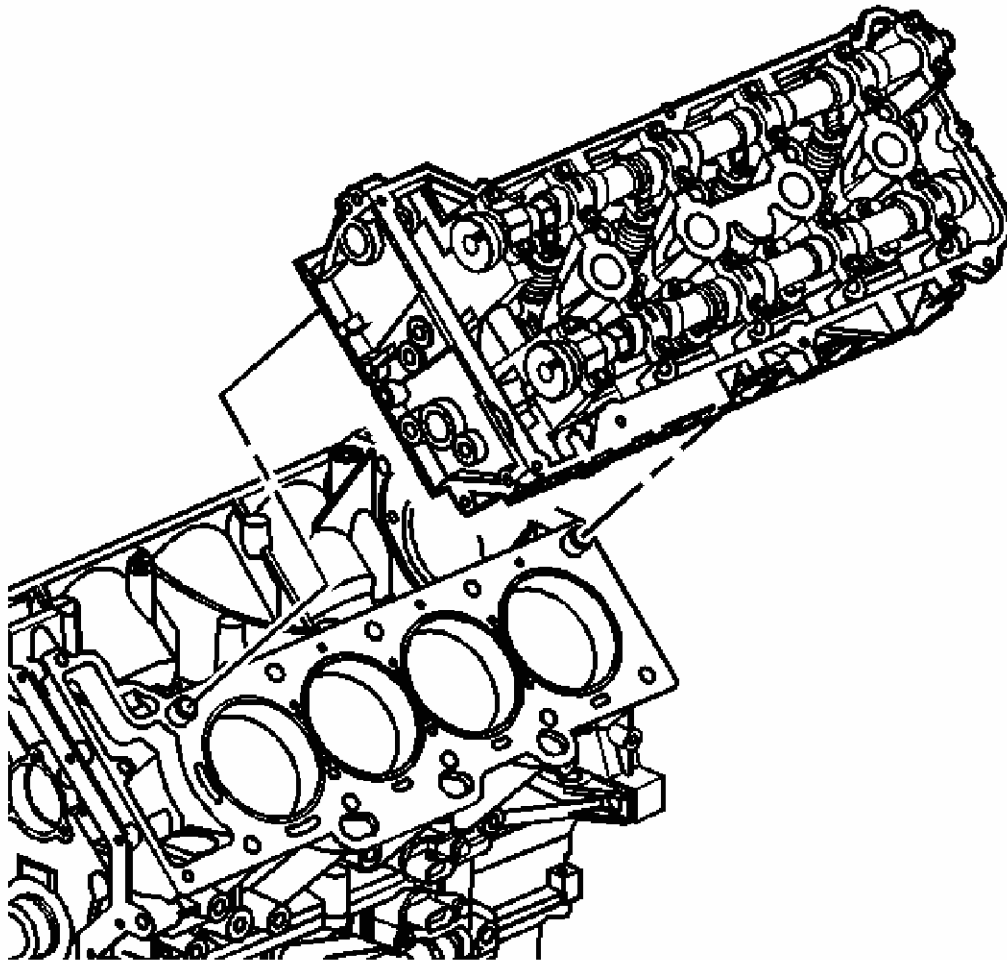


Fig. 307: View Of Cylinder Head With Alignment Dowels - Left
Courtesy of GENERAL MOTORS CORP.

3. Remove the left cylinder head. Make sure that no dowel guide pins are stuck in the cylinder head.

IMPORTANT: You must clean the thread sealant material from the cylinder head bolt holes in the cylinder block. Failure to do so could cause false torque readings during reassembly.

4. After removing the cylinder head, remove any remaining bolt thread sealant material from the threaded cylinder block holes.

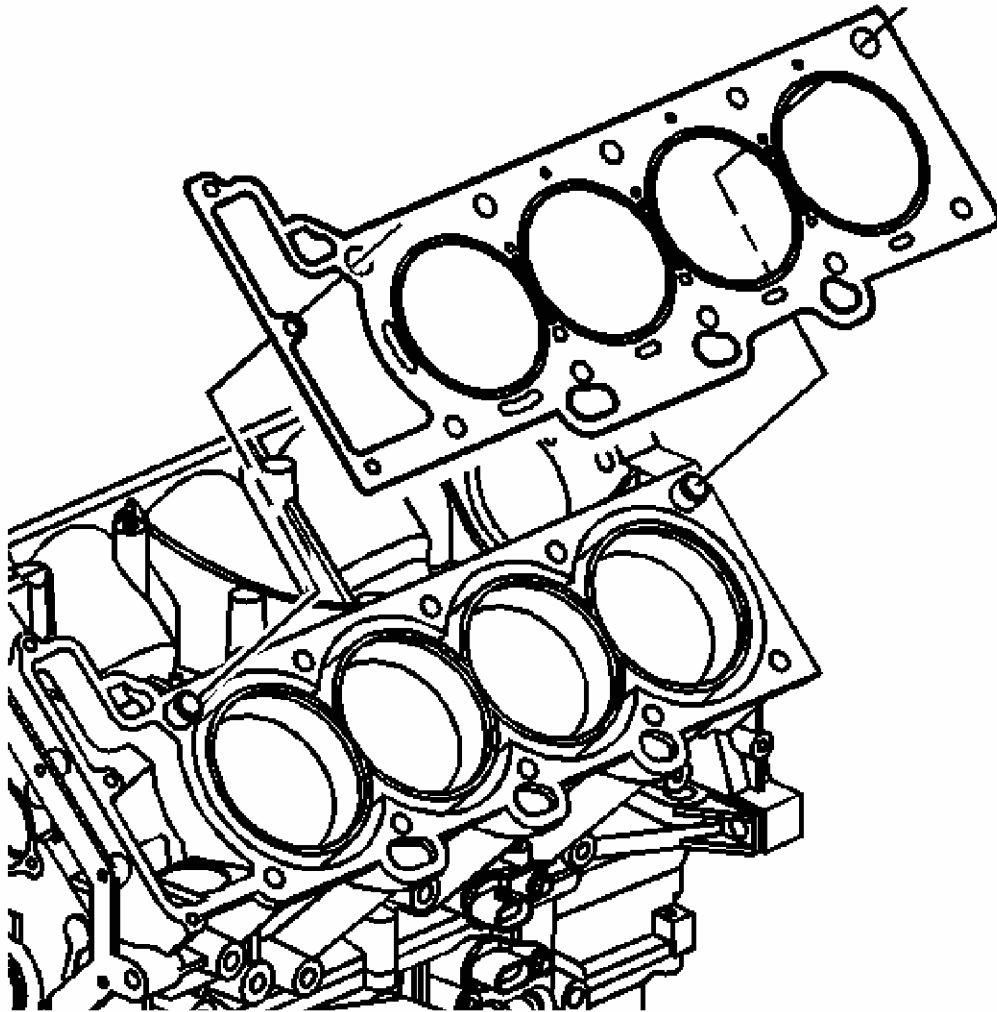


Fig. 308: View of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the cylinder head gasket.

5. Remove the left cylinder head gasket.
6. Remove all remaining gasket material from the cylinder head and cylinder block using the **J 28410** . See **Special Tools** .
7. Place the cylinder head on a flat, clean surface with the combustion chambers face-up in order to prevent damage to the deck face.

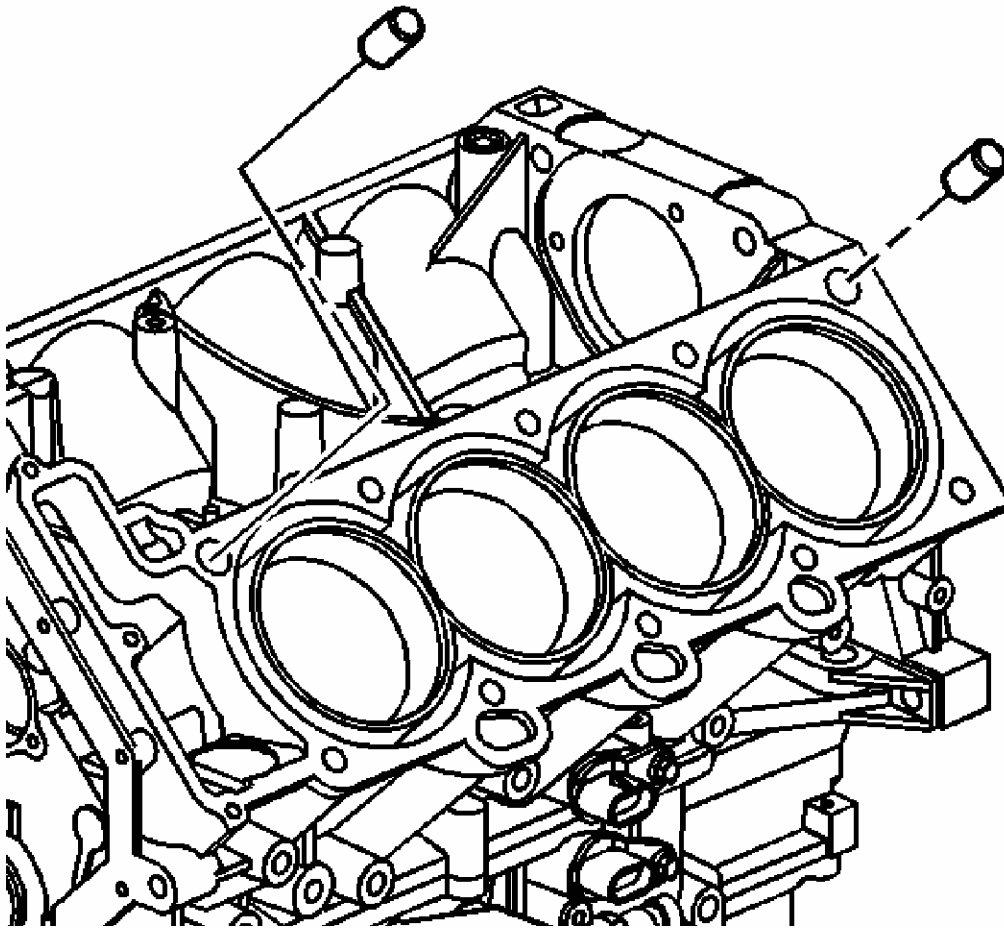


Fig. 309: Identifying Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS CORP.

8. Remove the cylinder head locating pins.

CYLINDER HEAD REMOVAL - RIGHT SIDE

TOOLS REQUIRED

J 28410 Gasket Remover. See Special Tools .

REMOVAL PROCEDURE

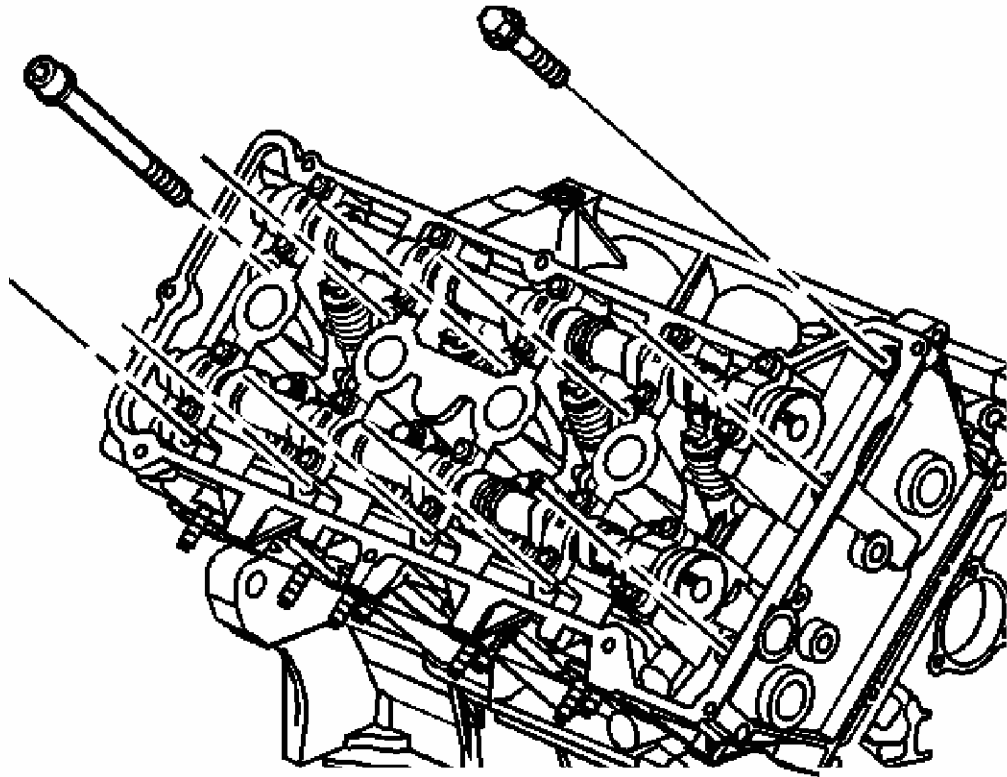


Fig. 310: View of Cylinder Head Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the three M6 external drive bolts from the front portion of the cylinder head.

IMPORTANT: DO NOT reuse the M11 cylinder head bolts.

2. Remove and discard the ten M11 internal drive cylinder head bolts.

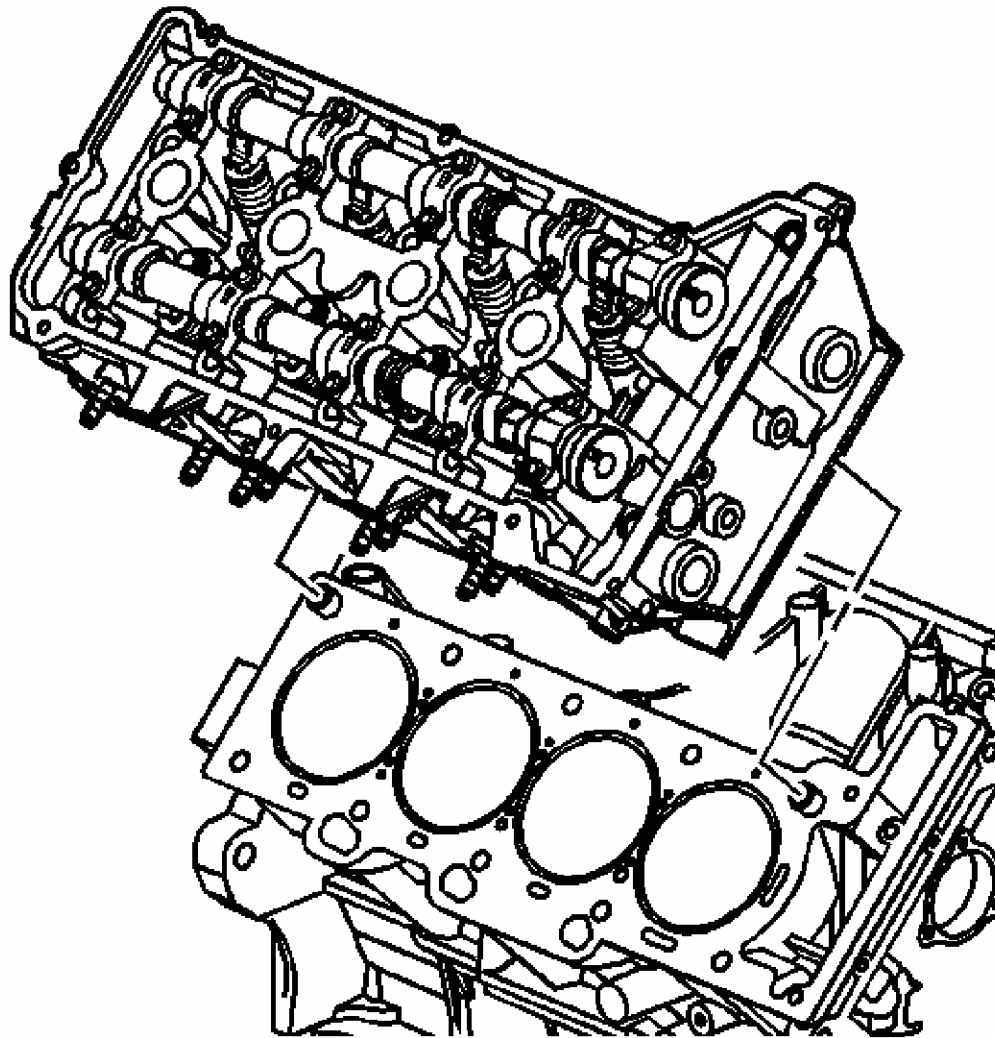


Fig. 311: View Of Cylinder Head With Alignment Dowels - Right
Courtesy of GENERAL MOTORS CORP.

3. Remove the right cylinder head. Make sure that no dowel guide pins are stuck in the cylinder head.

IMPORTANT: You must clean the thread sealant material from the cylinder head bolt holes in the cylinder block. Failure to do so could cause false torque readings during reassembly.

4. After removing the cylinder head, remove any remaining bolt thread sealant material from the threaded cylinder block holes.

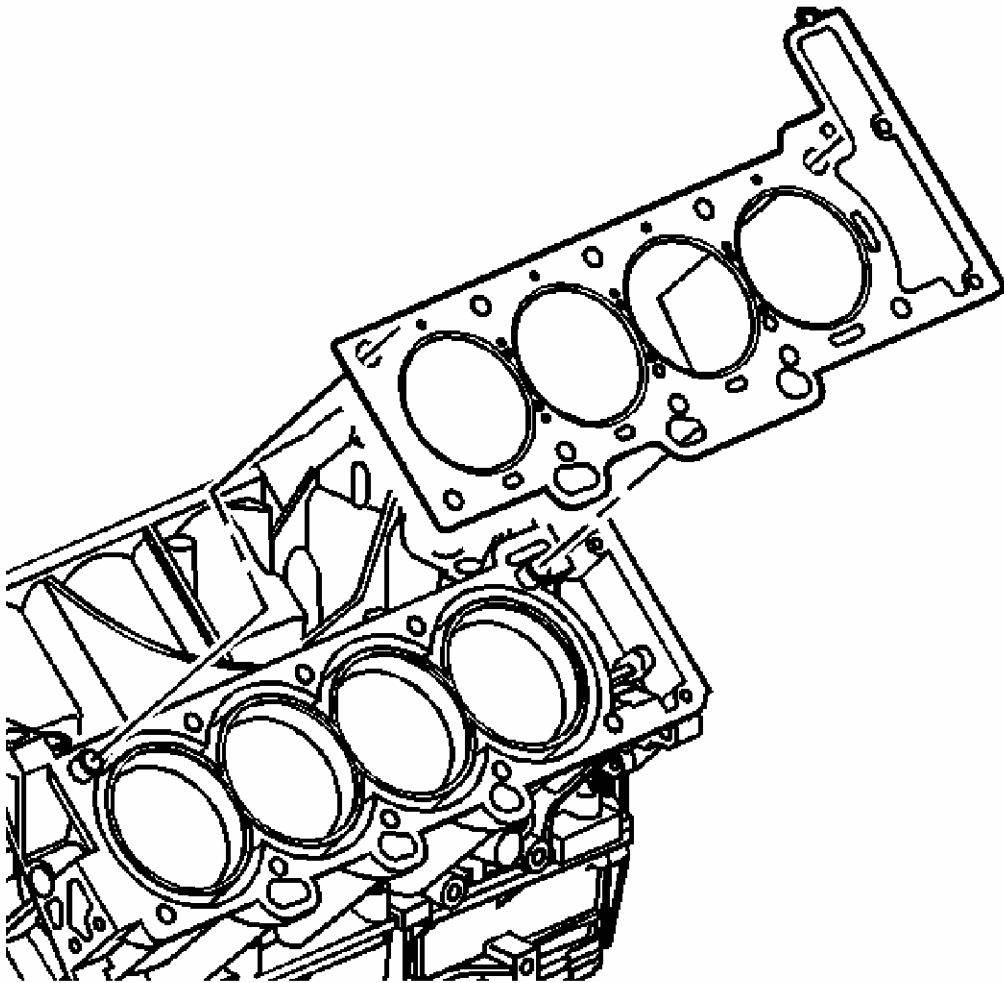


Fig. 312: View of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: DO NOT reuse the cylinder head gasket.

5. Remove the right cylinder head gasket.
6. Remove all remaining gasket material from the cylinder head and cylinder block using the **J 28410** . See **Special Tools** .
7. Place the cylinder head on a flat, clean surface with the combustion chambers face-up in order to prevent damage to the deck face.

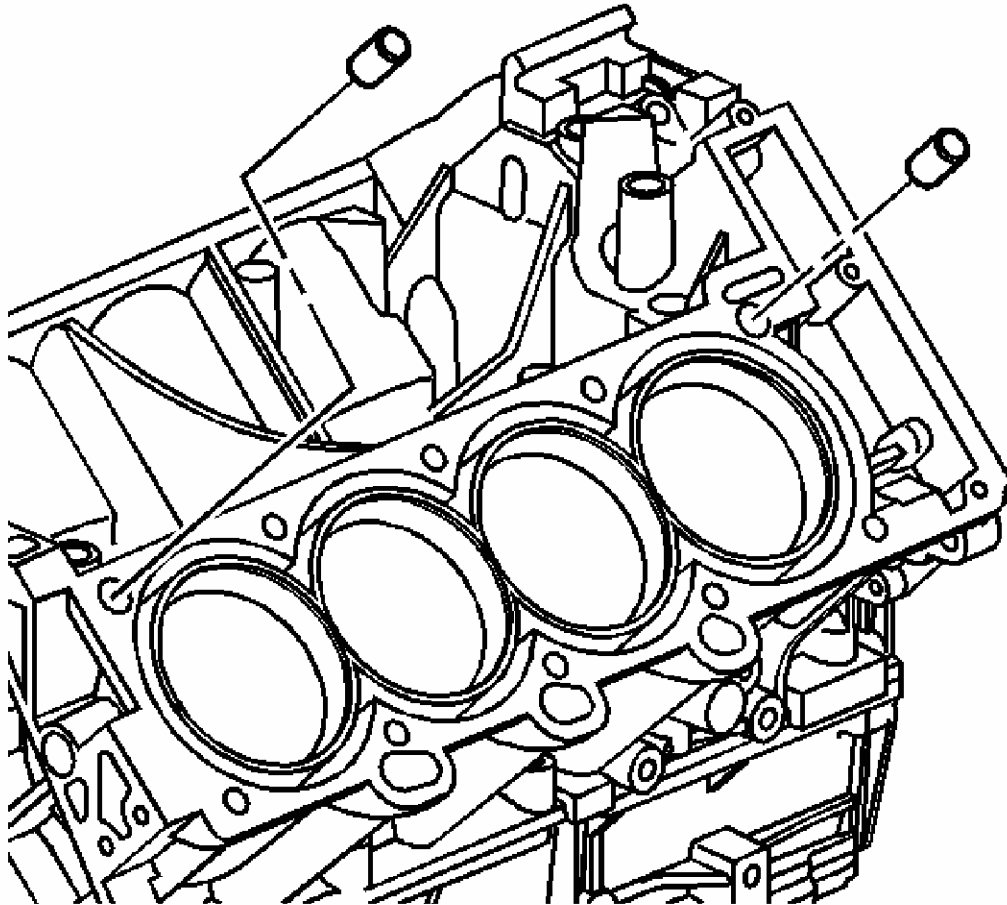


Fig. 313: Identifying Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS CORP.

8. Remove the cylinder head locating pins.

OIL PAN REMOVAL

REMOVAL PROCEDURE

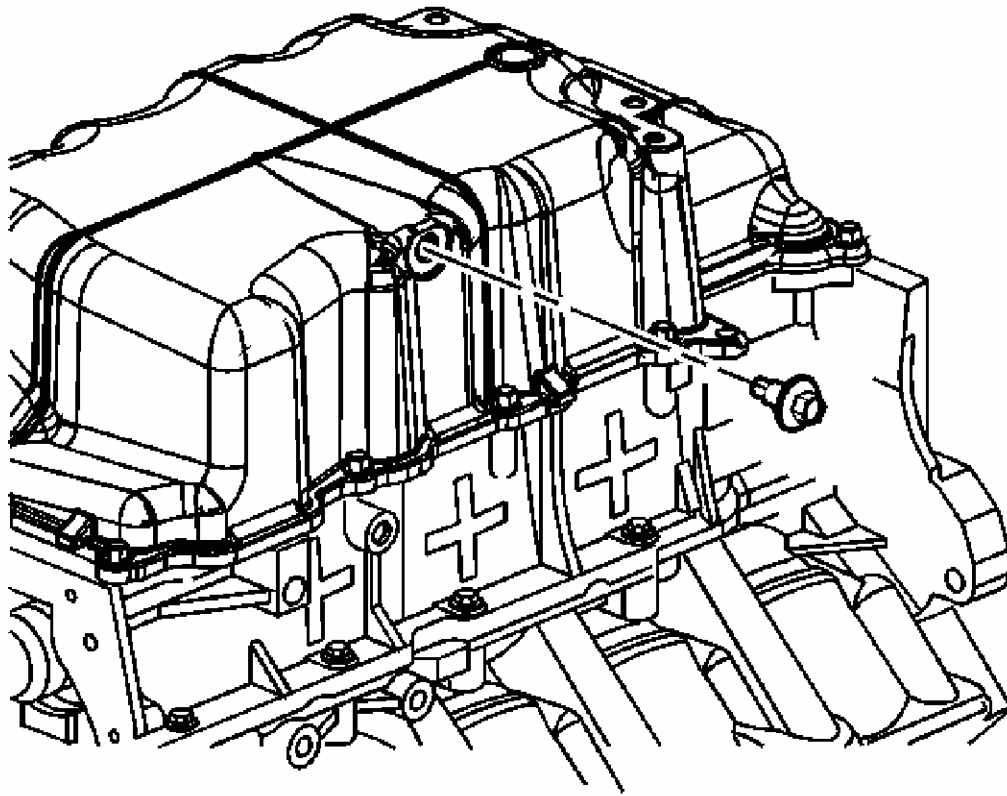


Fig. 314: View Of Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

1. Rotate the engine so that the oil pan is facing up.
2. Remove the oil pan drain plug.

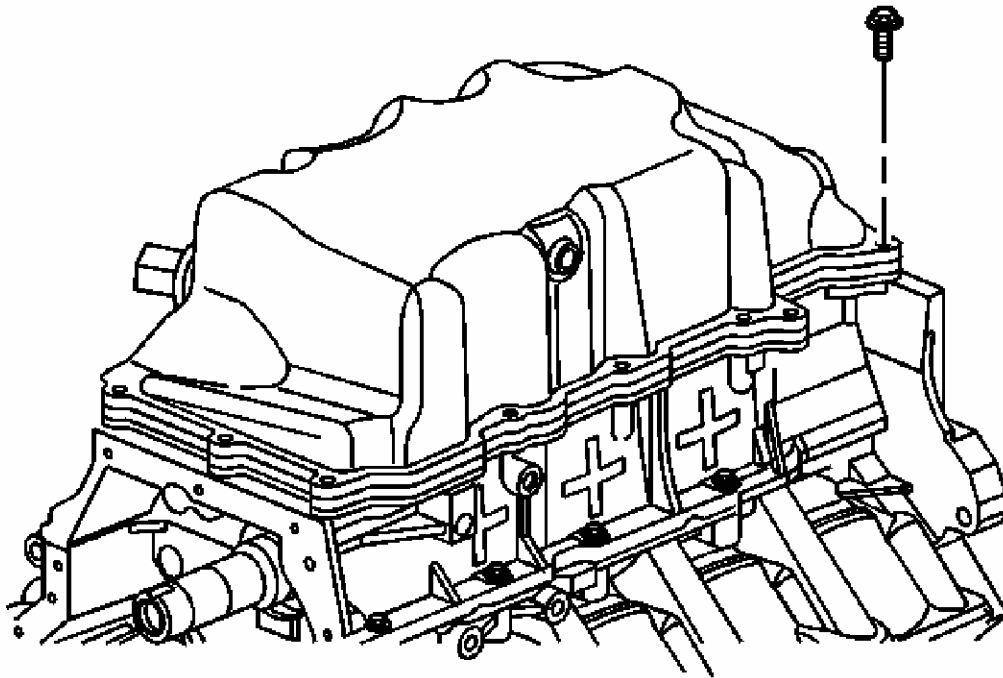


Fig. 315: Identifying Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pan bolts.

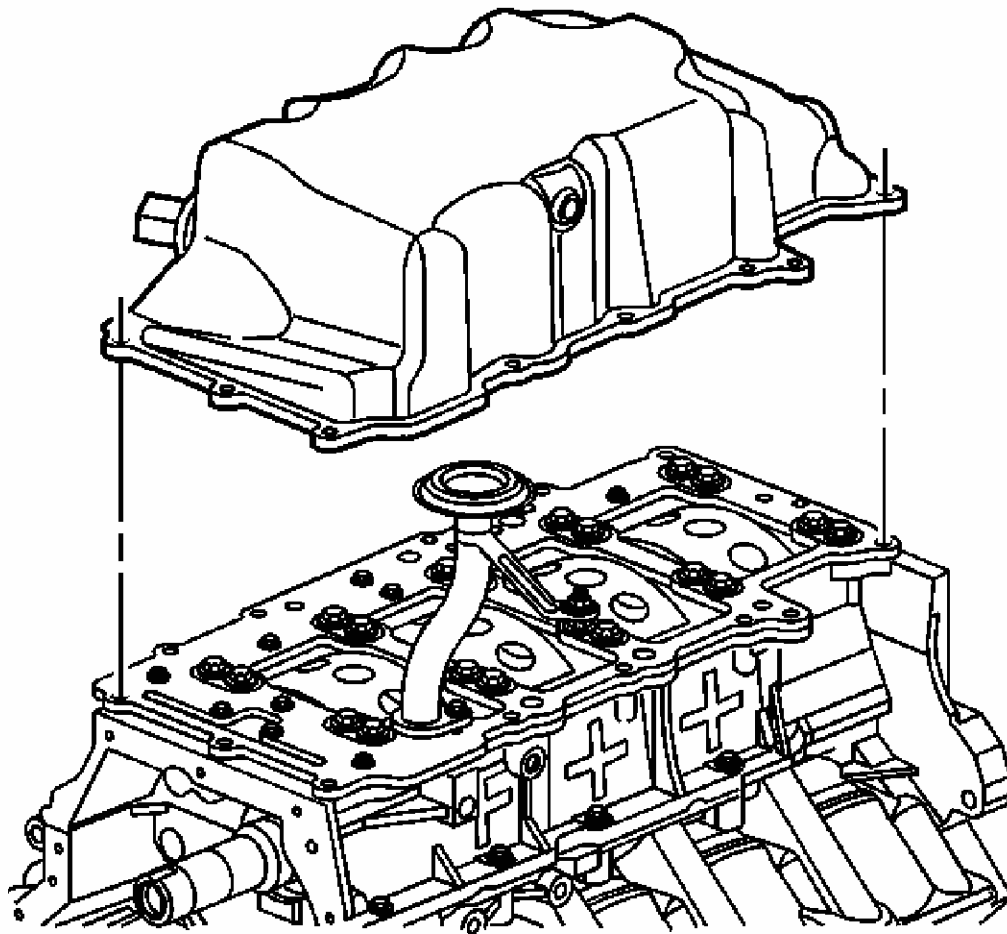


Fig. 316: Removing Oil Pan
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil pan from the lower crankcase oil distribution manifold plate.

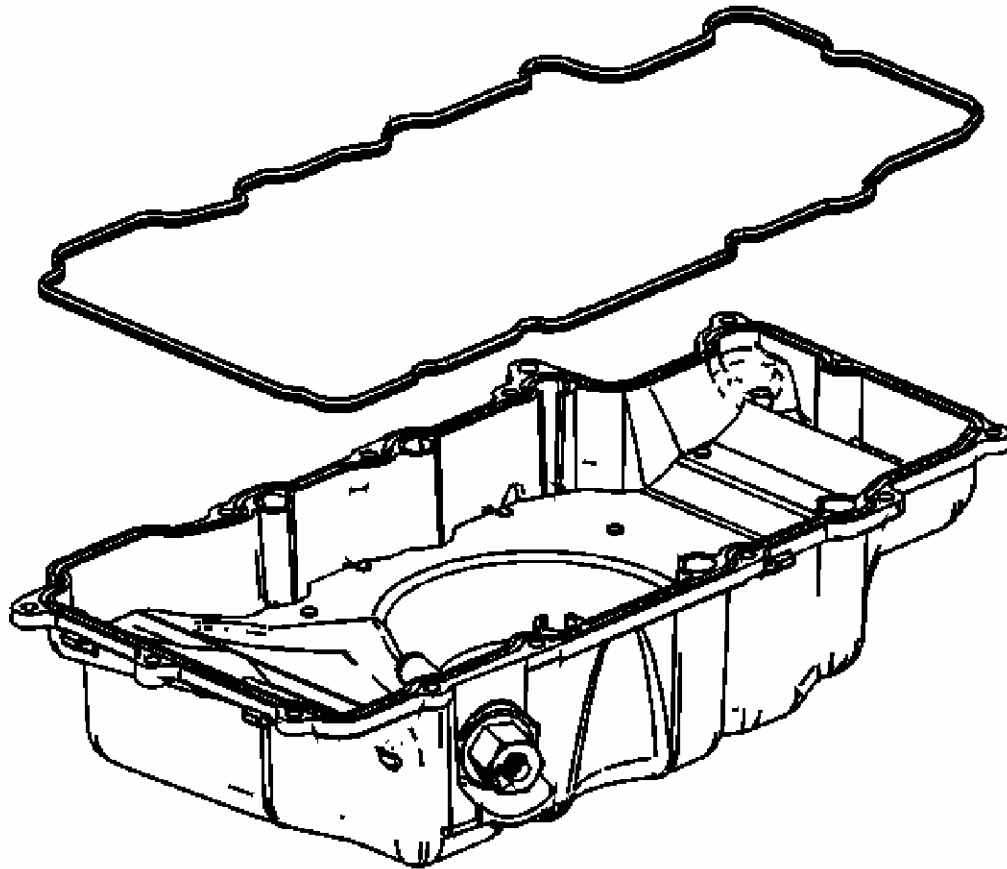


Fig. 317: View of Oil Pan Gasket
Courtesy of GENERAL MOTORS CORP.

5. Remove and discard the oil pan gasket.

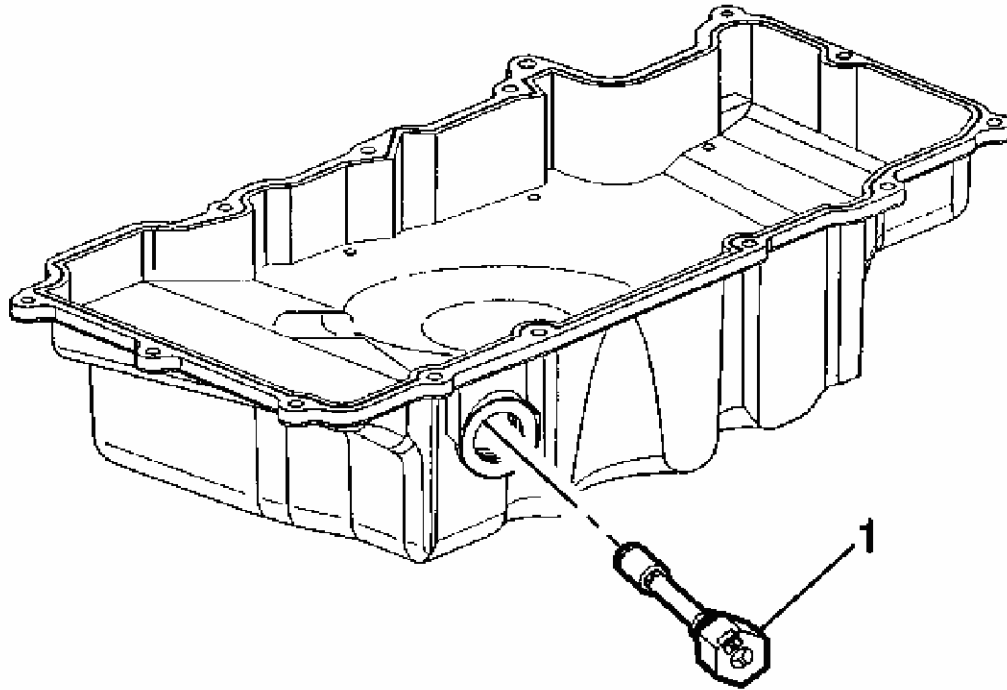


Fig. 318: Identifying Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil level sensor (1).

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REMOVAL

REMOVAL PROCEDURE

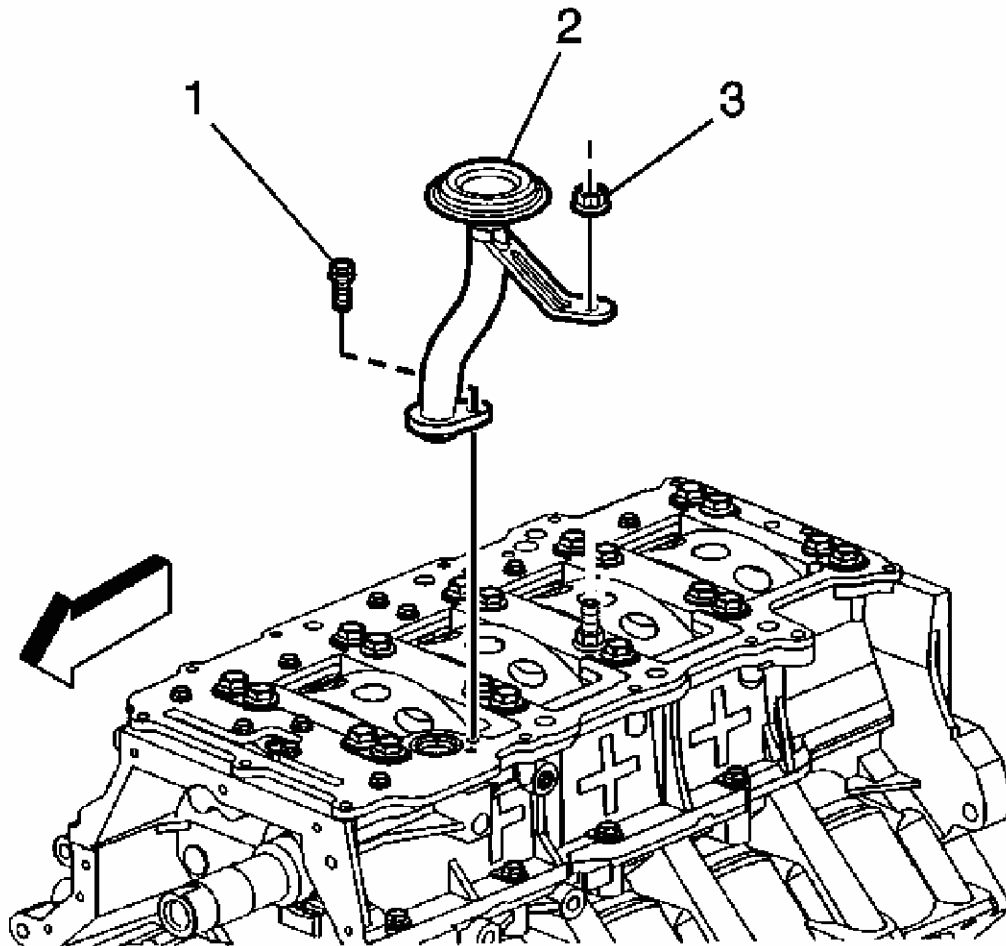


Fig. 319: Identifying Oil Pump Pickup Tube Support Nut, Oil Manifold Mounting Bolt & Oil Pump Pickup Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump pickup tube retaining nut (3) from the main bearing stud.
2. Remove the retaining bolt (1) from the oil manifold plate.
3. Remove the oil pump pickup tube (2).

LOWER CRANKCASE REMOVAL

REMOVAL PROCEDURE

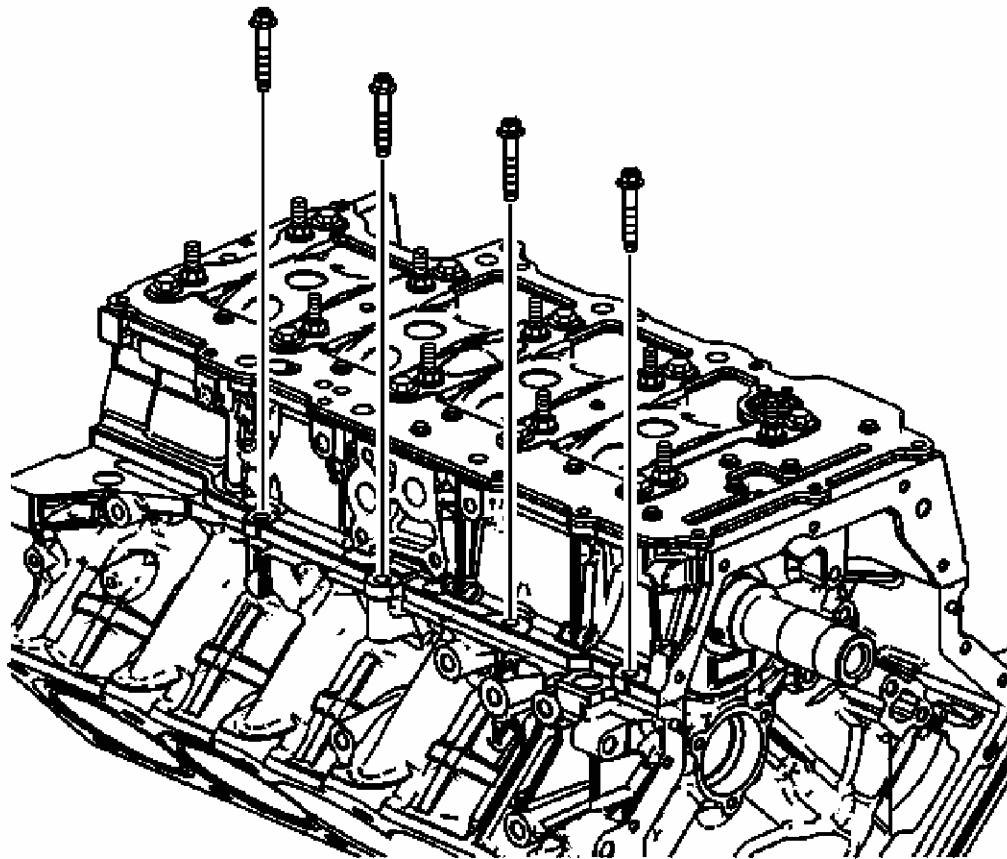


Fig. 320: Identifying Lower Crankcase Perimeter Bolts - Left Side
Courtesy of GENERAL MOTORS CORP.

1. Remove the 4 lower crankcase perimeter bolts along the left side of the engine.

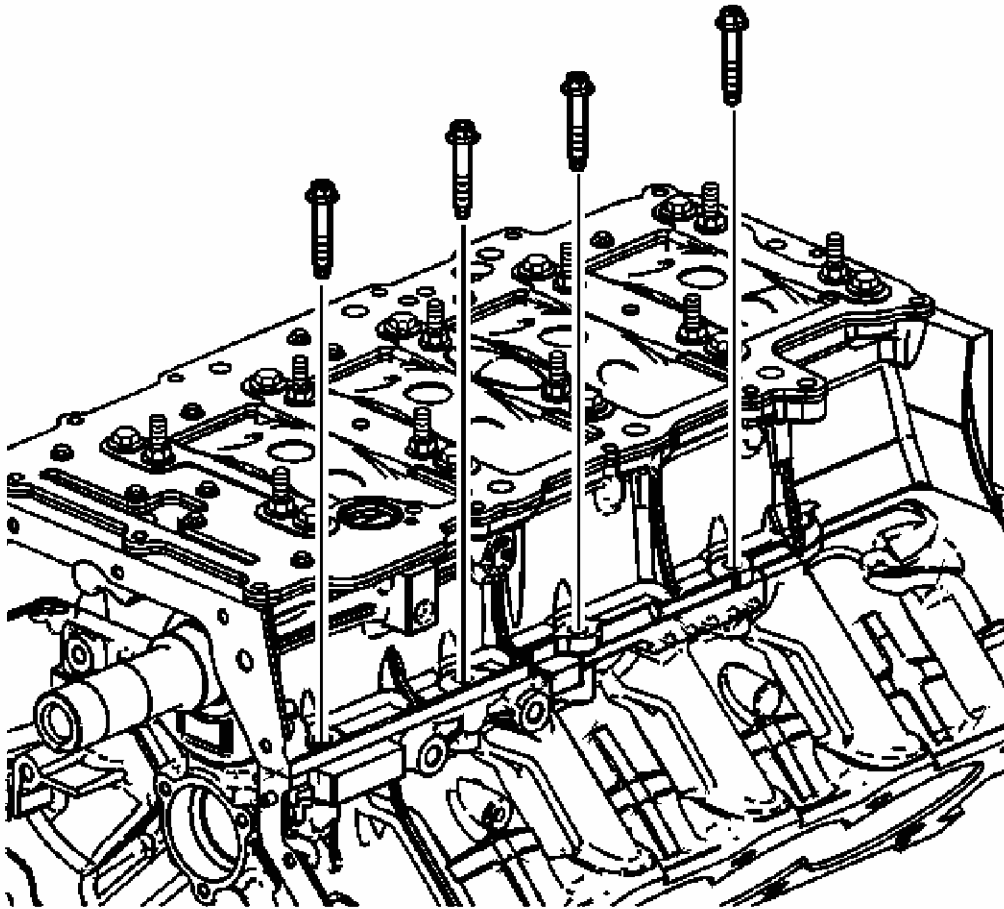


Fig. 321: Identifying Lower Crankcase Perimeter Bolts - Right Side
Courtesy of GENERAL MOTORS CORP.

2. Remove the 4 lower crankcase perimeter bolts along the right side of the engine.

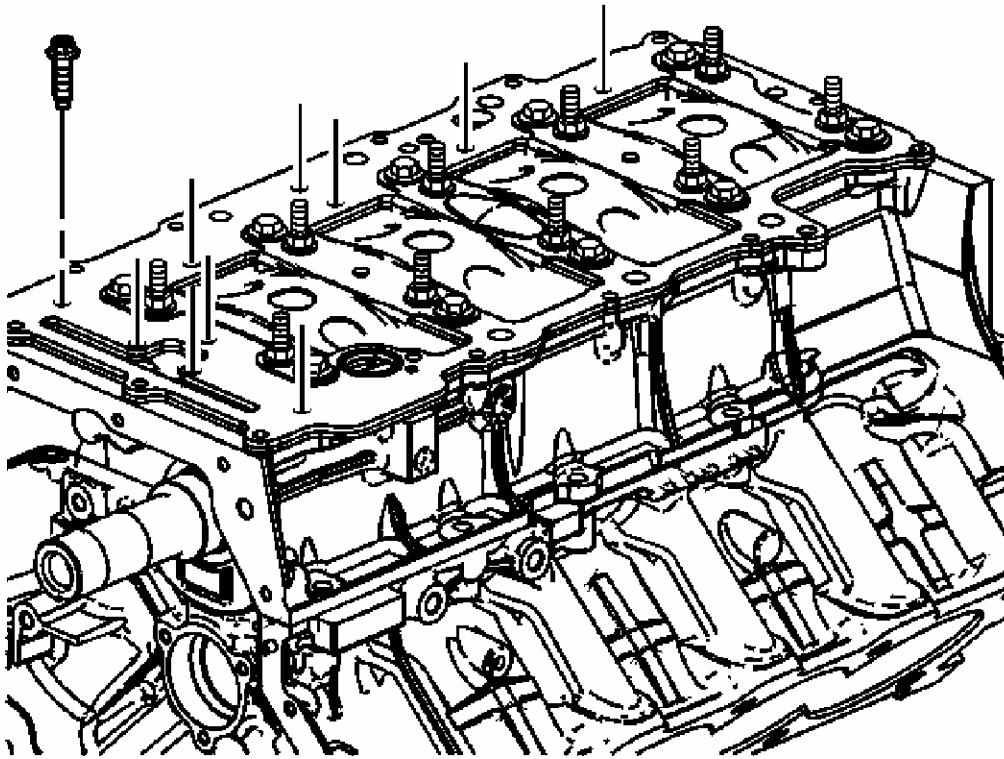


Fig. 322: Identifying Oil Manifold Plate Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil manifold plate bolts.

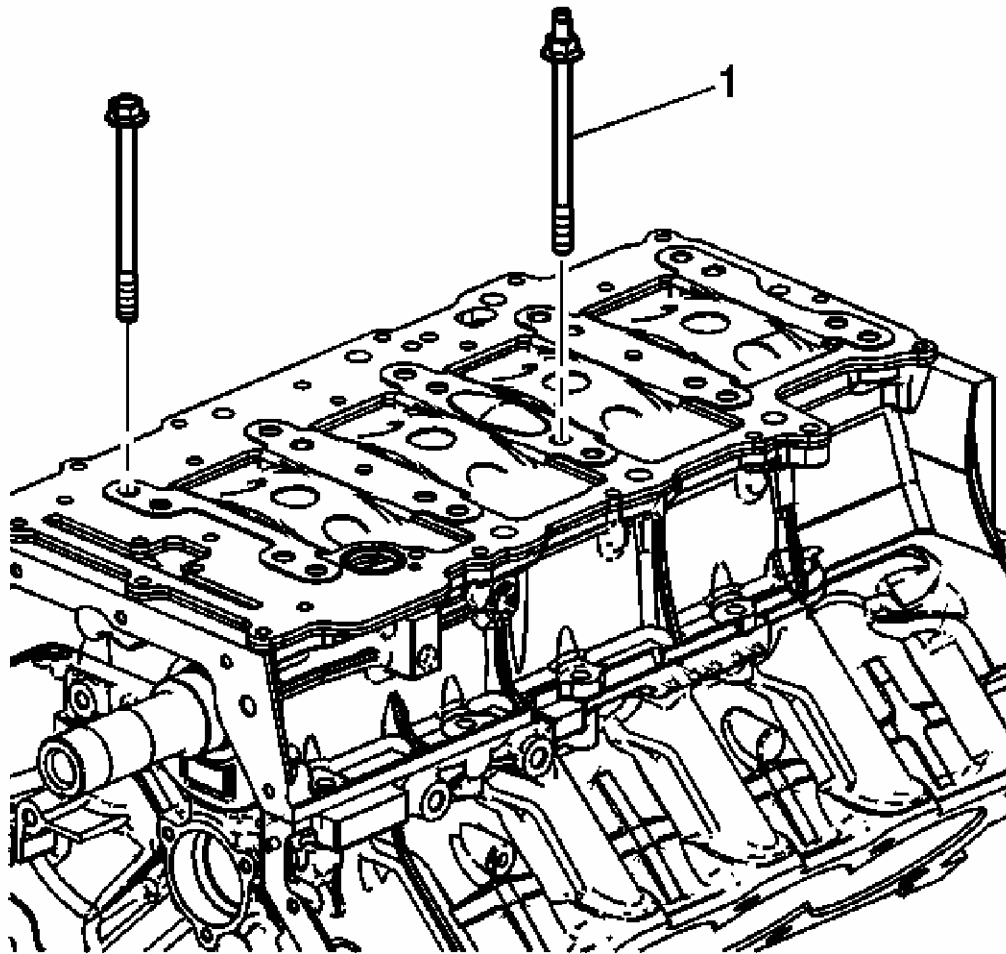


Fig. 323: Locating Single Stud-End Bolt
Courtesy of GENERAL MOTORS CORP.

4. Remove the main bearing bolts. Note the location of the single stud-end bolt (1) used to attach the oil pump pickup tube.

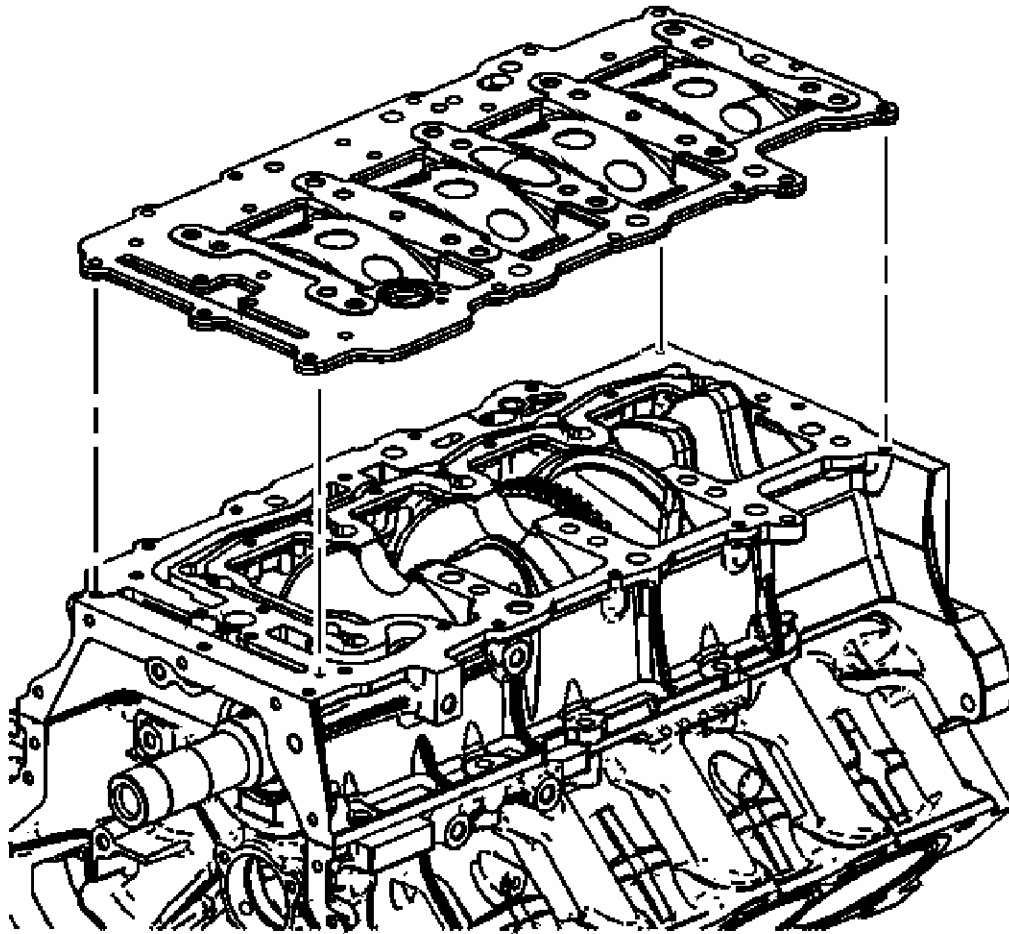


Fig. 324: Identifying Oil Manifold Plate
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil manifold plate.

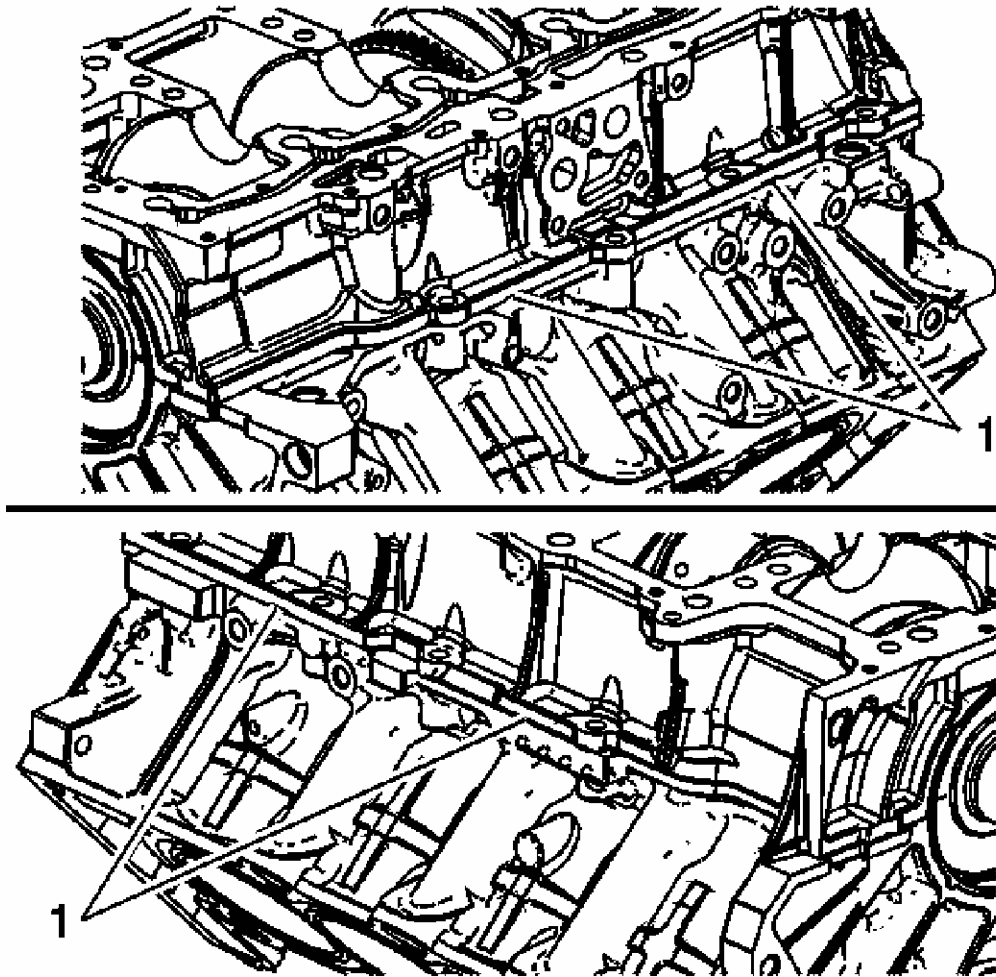


Fig. 325: Separating Crankcase Halves
Courtesy of GENERAL MOTORS CORP.

NOTE: Use a plastic pry tool when prying case halves apart to prevent damage to the Upper and Lower Crankcase surface. Do not continue to push the pry tool in the crankcase as the Upper and Lower Crankcase halves separate. This may damage the sealing surface.

6. Working on either side of the lower crankcase, separate the crankcase halves by alternately prying in the grooves (1) provided until the lower crankcase is free of the dowel pins.

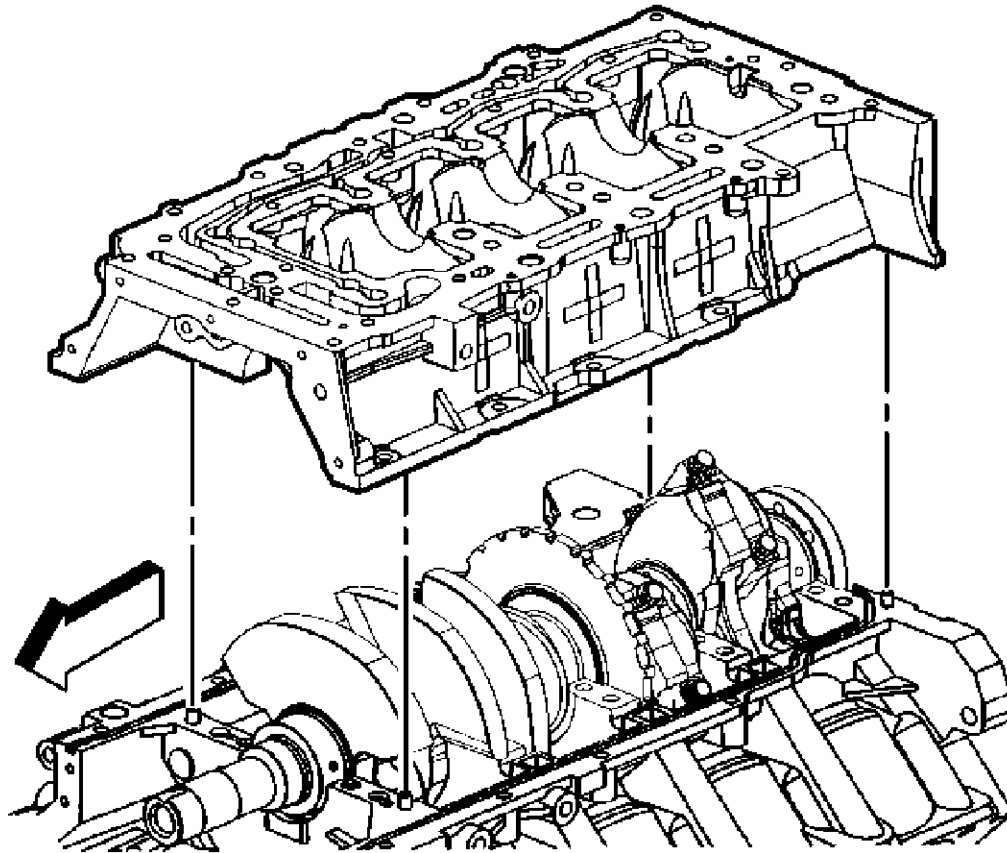


Fig. 326: View Of Lower Crankcase
Courtesy of GENERAL MOTORS CORP.

7. Remove the lower crankcase.

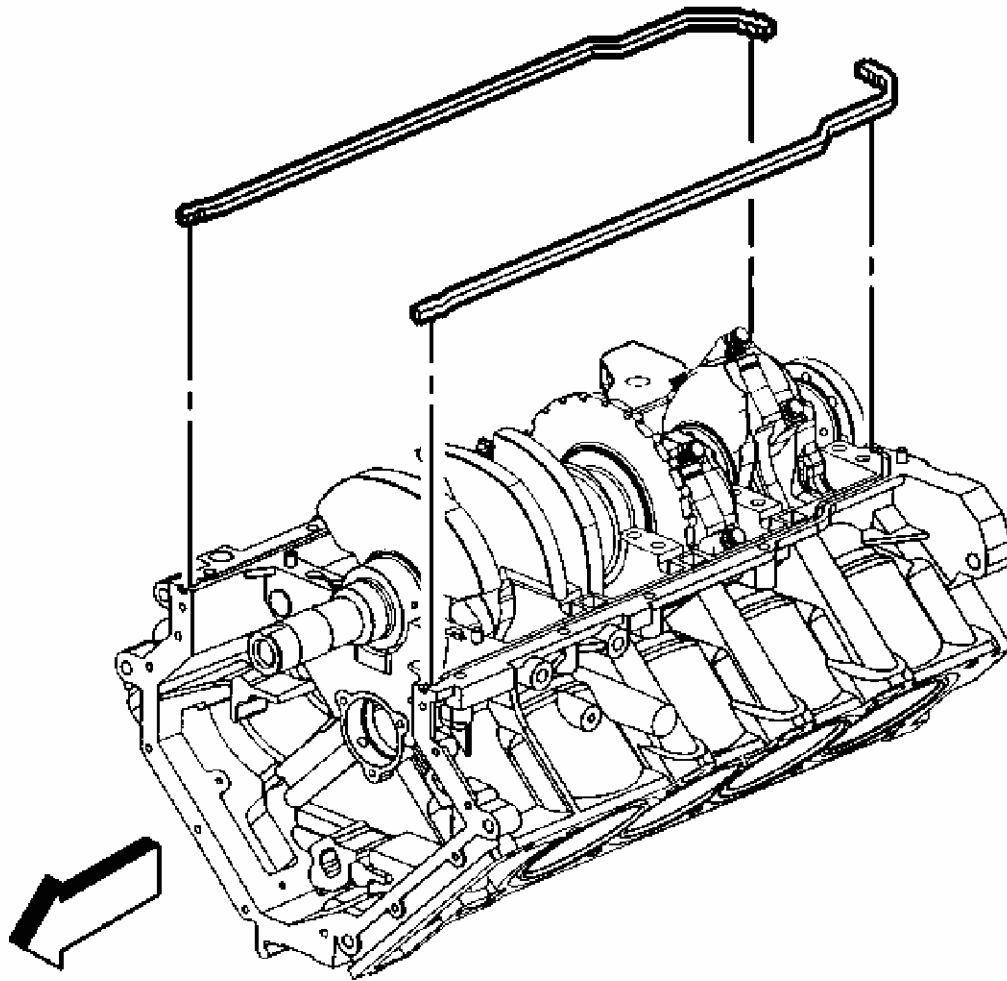


Fig. 327: View of Upper-to-lower Crankcase Seals
Courtesy of GENERAL MOTORS CORP.

8. Remove and discard the upper-to-lower crankcase seals.

PISTON, CONNECTING ROD AND BEARING REMOVAL

REMOVAL PROCEDURE

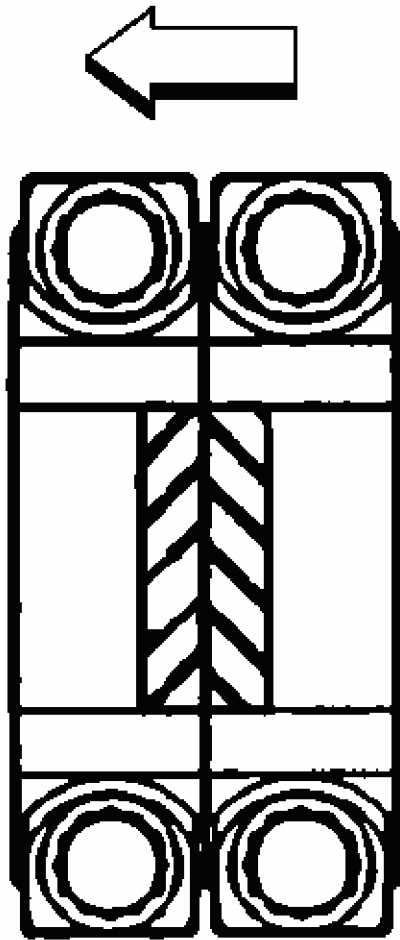


Fig. 328: View Of Paired Connecting Rod Bearing Cap Notches
Courtesy of GENERAL MOTORS CORP.

1. Note the orientation of paired connecting rods on each crankpin. The notches in the connecting rod cap must be facing each other.
2. Before removing the connecting rods, check the connecting rod end play using the following procedure:
 1. Tap the connecting rod to one end of the crankshaft journal with a dead-blow or wooden hammer.
 2. Using feeler gages, measure the clearance between the crankshaft counterweight and the connecting rod.
 3. The connecting rod end play should not exceed 0.500 mm (0.020 in).
 4. If the end play exceeds the specified limits, measure the width of the crankpin end

of the connecting rod.

5. The width of the crankpin end of the connecting rod should be 21.745 - 21.805 mm (0.856 - 0.858 in).
 6. If the connecting rod width is significantly smaller than specified and severe wear is present on the side of the connecting rod, replace the connecting rod.
 7. If the connecting rod width is within specification and excessive scoring is present on the crankshaft journals, replace the crankshaft.
3. Using a paint stick or permanent marker, number each piston face. Draw an arrow along the centerline of the piston pointing toward the front of the engine.

NOTE: Do not use a stamp, punch or any other method that may distort or stress the connecting rod or connecting rod cap. Extensive engine damage may result from a connecting rod that is distorted or stressed.

4. Mark the cylinder number on the connecting rod and the connecting rod cap with paint stick, scribe or permanent marker. The connecting rod caps must remain with the original connecting rod.

NOTE: Powdered metal connecting rods have rod bolts which yield when torqued. If the rod bolts are loosened or removed the rod bolts must be replaced. Rod bolts that are not replaced will not torque to the correct clamp load and can lead to serious engine damage.

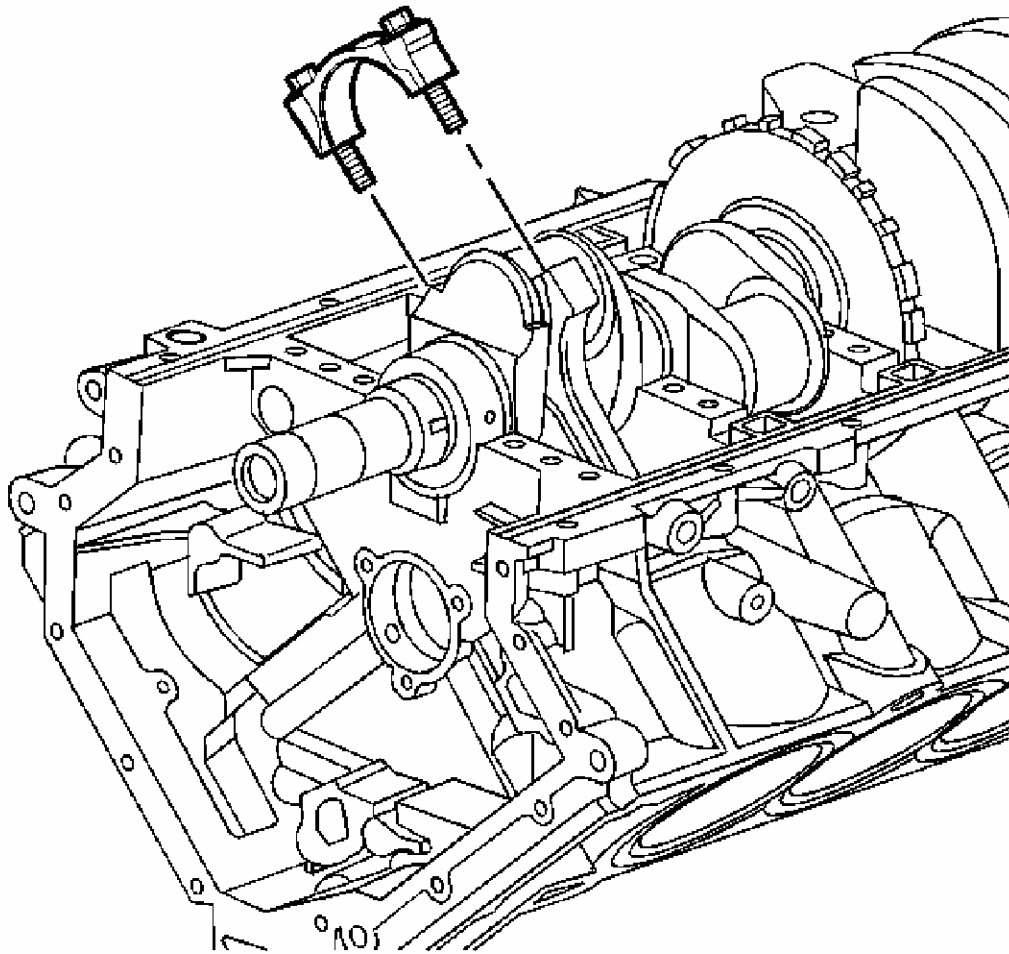


Fig. 329: View Of Rod Cap & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the connecting rod bolts.
6. Remove the connecting rod cap.

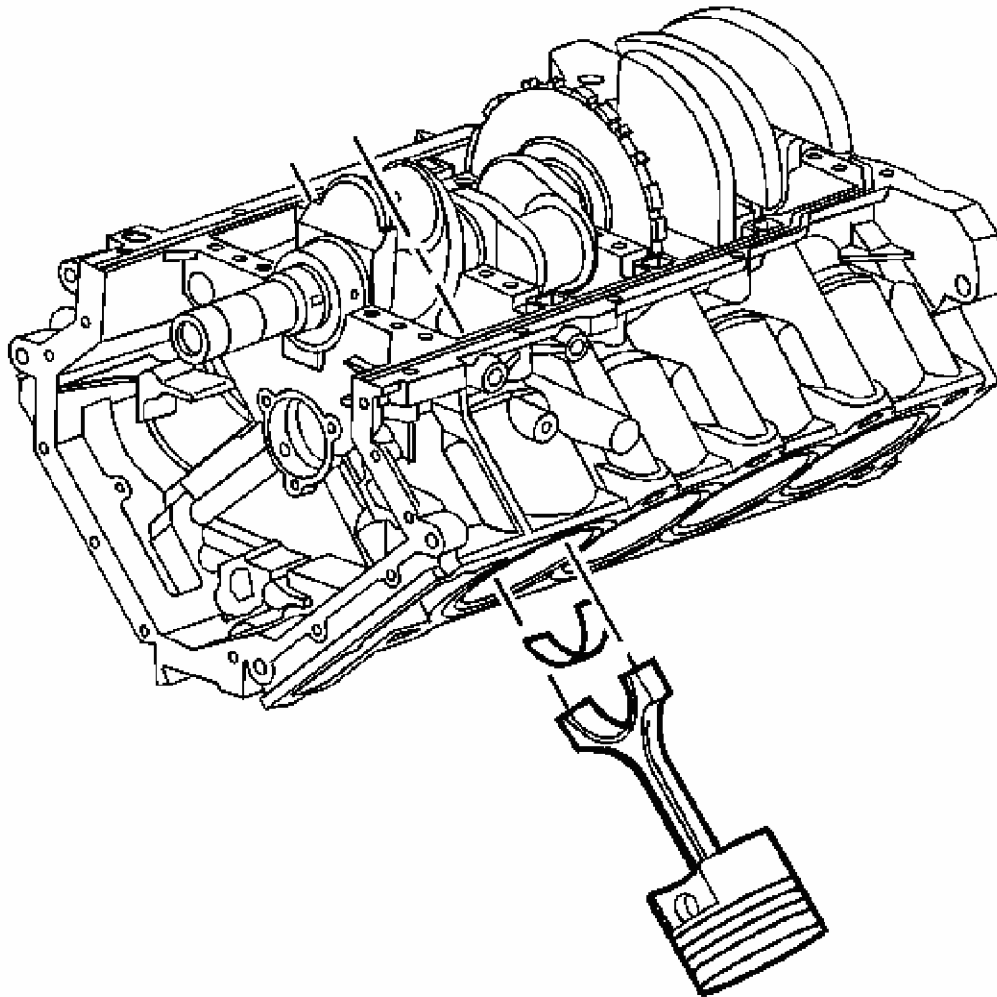


Fig. 330: View Of Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS CORP.

7. Push the connecting rod and the piston assembly down through the top of the cylinder. Do not scratch the crankshaft journal or the cylinder wall when removing the connecting rod and the piston assembly.
8. Remove the connecting rod bearings. NEVER re-use the connecting rod bearings. Refer to **Crankshaft and Bearing Cleaning and Inspection** for inspection.
9. Reattach the connecting rod cap to the connecting to prevent damage to their mating surfaces. The cap and rod are a matched set and must be kept together.

CRANKSHAFT AND BEARING REMOVAL

CRANKSHAFT REMOVAL PROCEDURE

1. Before removing the crankshaft, measure the crankshaft end play using the following procedure:
 1. Reinstall the lower crankcase.
 2. Place a dial indicator at the crankshaft nose.
 3. Gently force the crankshaft to the extreme front and rear positions with a pry tool while monitoring the movement of the dial indicator.
 4. The crankshaft end play should not exceed 0.05-0.5 mm (0.002-0.020 in).
 5. If the specifications are exceeded, replace the thrust bearing.
 6. If a new thrust bearing does not bring the tolerances within specification, replace the crankshaft.
 7. Remove the lower crankcase.
2. Locate or fabricate two V-blocks to support the crankshaft.

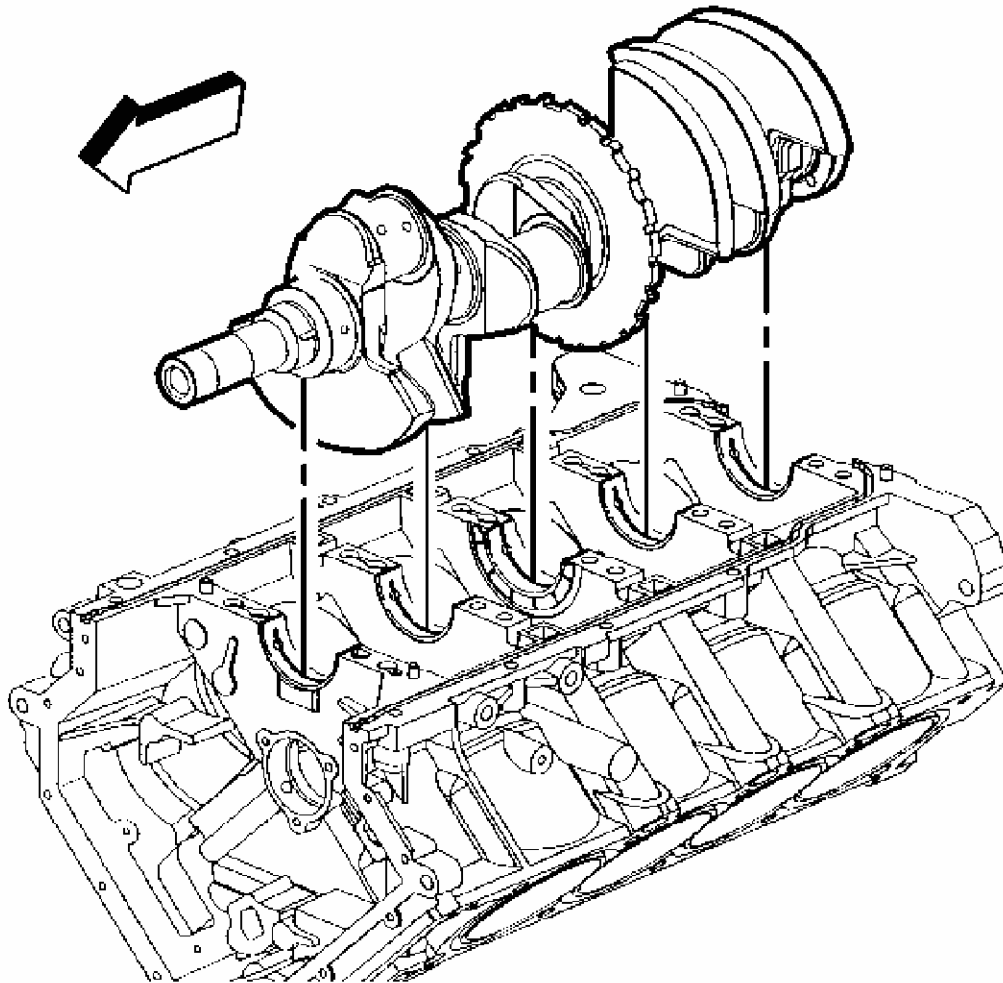


Fig. 331: View Of Crankshaft & Engine Block
Courtesy of GENERAL MOTORS CORP.

3. Using two hands, lift the crankshaft straight up from the engine block.
4. Place the crankshaft on the V-blocks in a secure place.

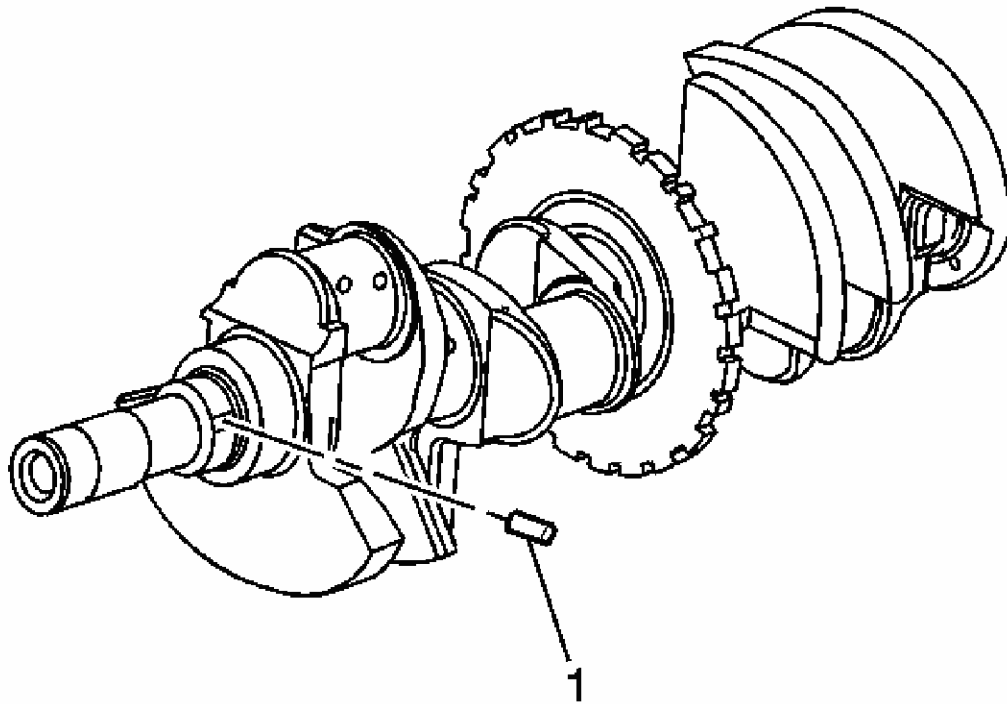


Fig. 332: Identifying Crankshaft Sprocket Drive Pin
Courtesy of GENERAL MOTORS CORP.

5. If damaged, remove the crankshaft sprocket drive pin (1) from the nose of the crankshaft.

CRANKSHAFT BEARING REMOVAL PROCEDURE

1. Prepare a piece of cardboard or equivalent, numbered one to five for bearing identification. Main bearing journals are numbered from the front of the engine.

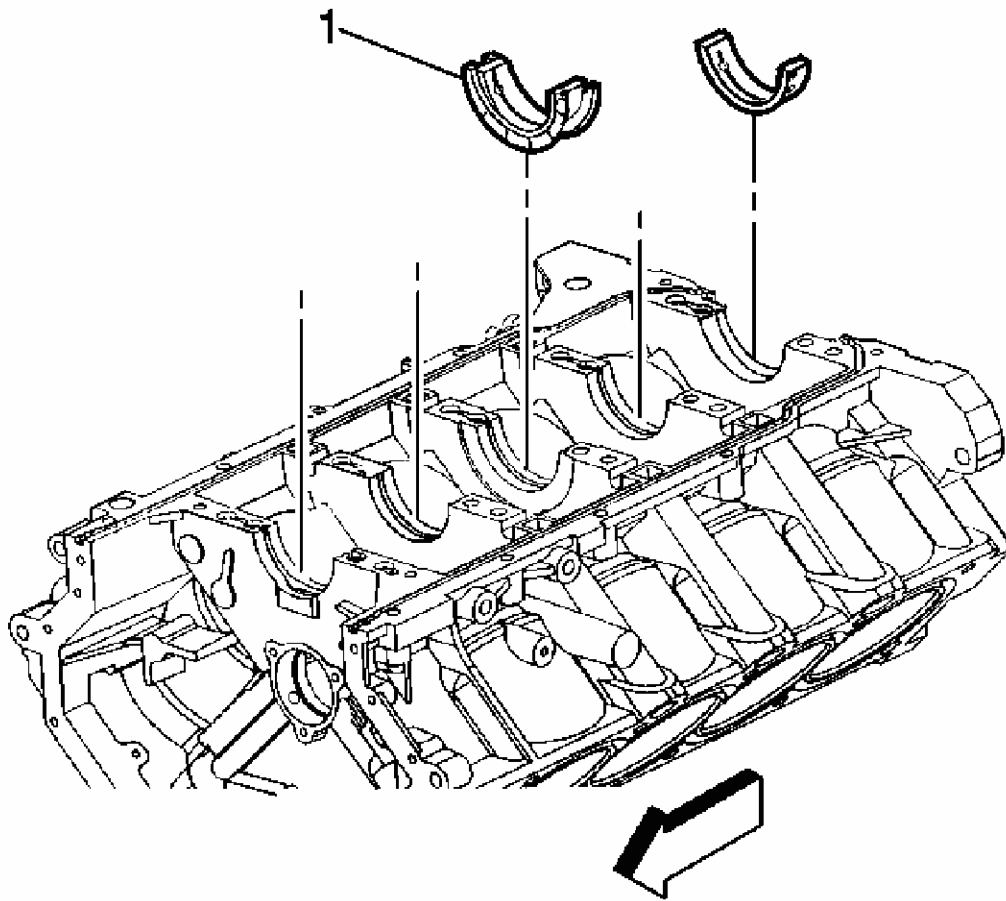


Fig. 333: View Of Thrust Bearing
Courtesy of GENERAL MOTORS CORP.

2. Remove the upper crankshaft bearing halves from the cylinder block. Note the position of the thrust bearing (1) at the number three journal.
3. Place the upper main bearing halves on the cardboard in the correct positions. Note that the number three bearing is the thrust bearing.

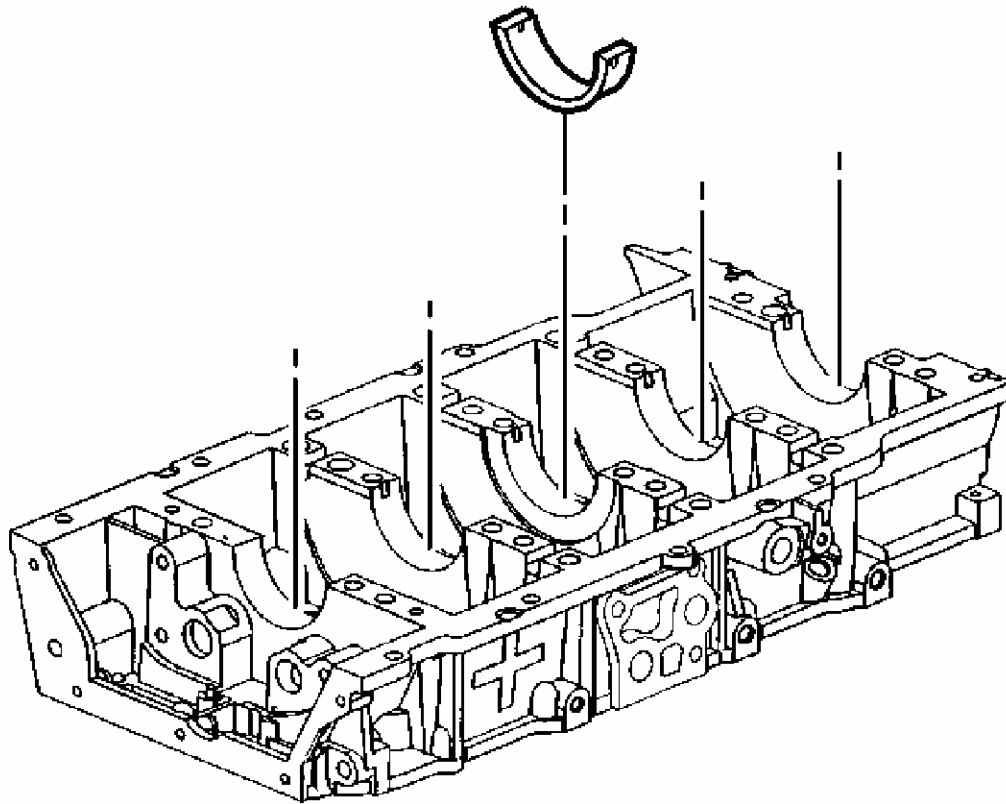


Fig. 334: View Of Lower Main Bearing Halves
Courtesy of GENERAL MOTORS CORP.

4. Remove the lower main bearing halves from the lower crankcase.
5. Place the lower main bearing halves in the correct positions on the cardboard.

ENGINE BLOCK DISASSEMBLE - UPPER

DISASSEMBLY PROCEDURE

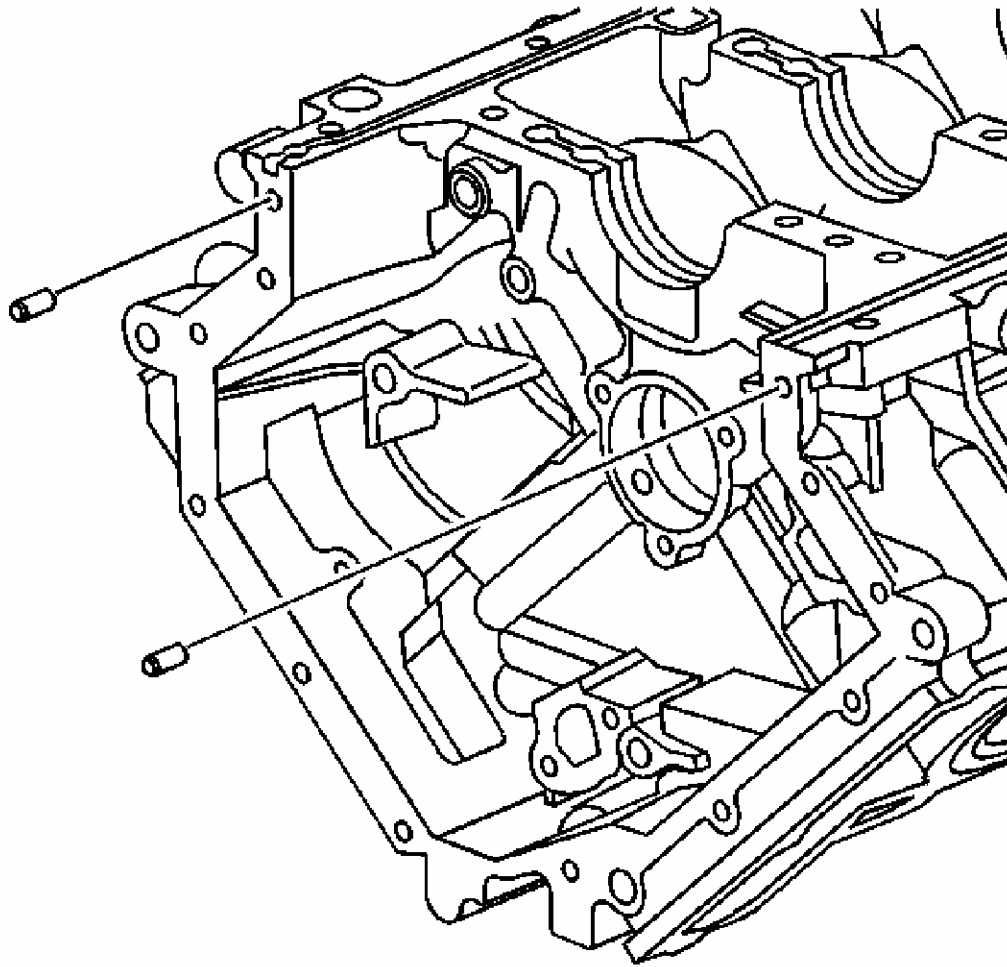


Fig. 335: Identifying Engine Front Cover Dowel Pins
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover dowel pins.

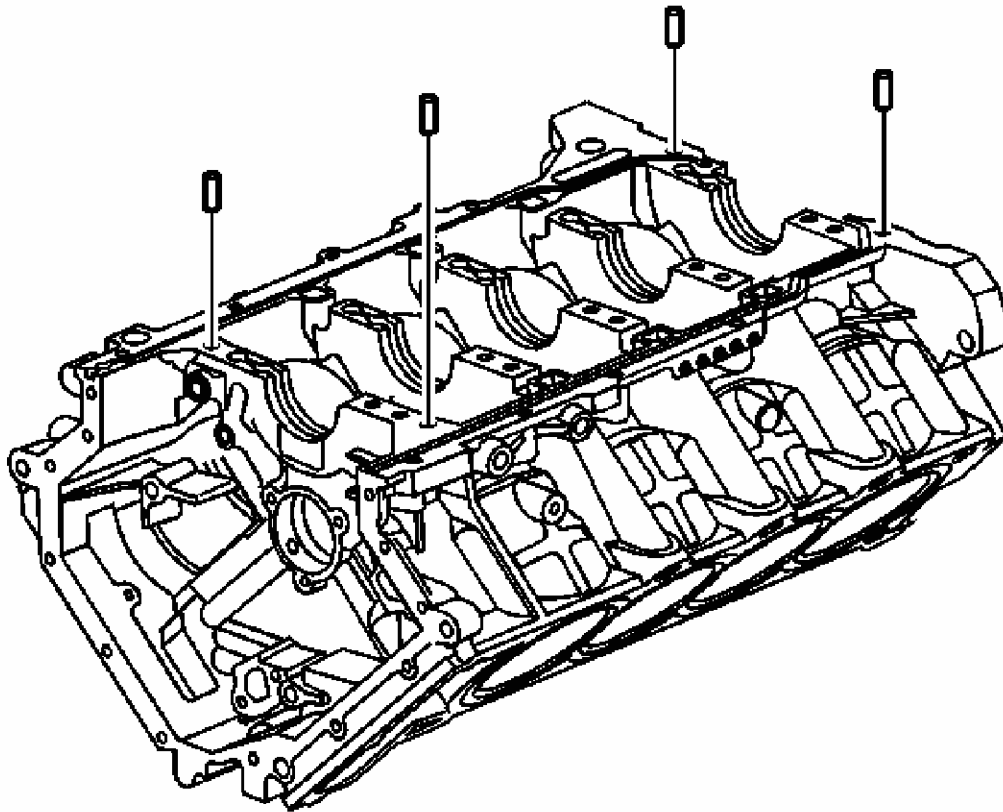


Fig. 336: Identifying Lower Crankcase Locating Dowel Pins
Courtesy of GENERAL MOTORS CORP.

2. Remove the lower crankcase locating dowel pins.

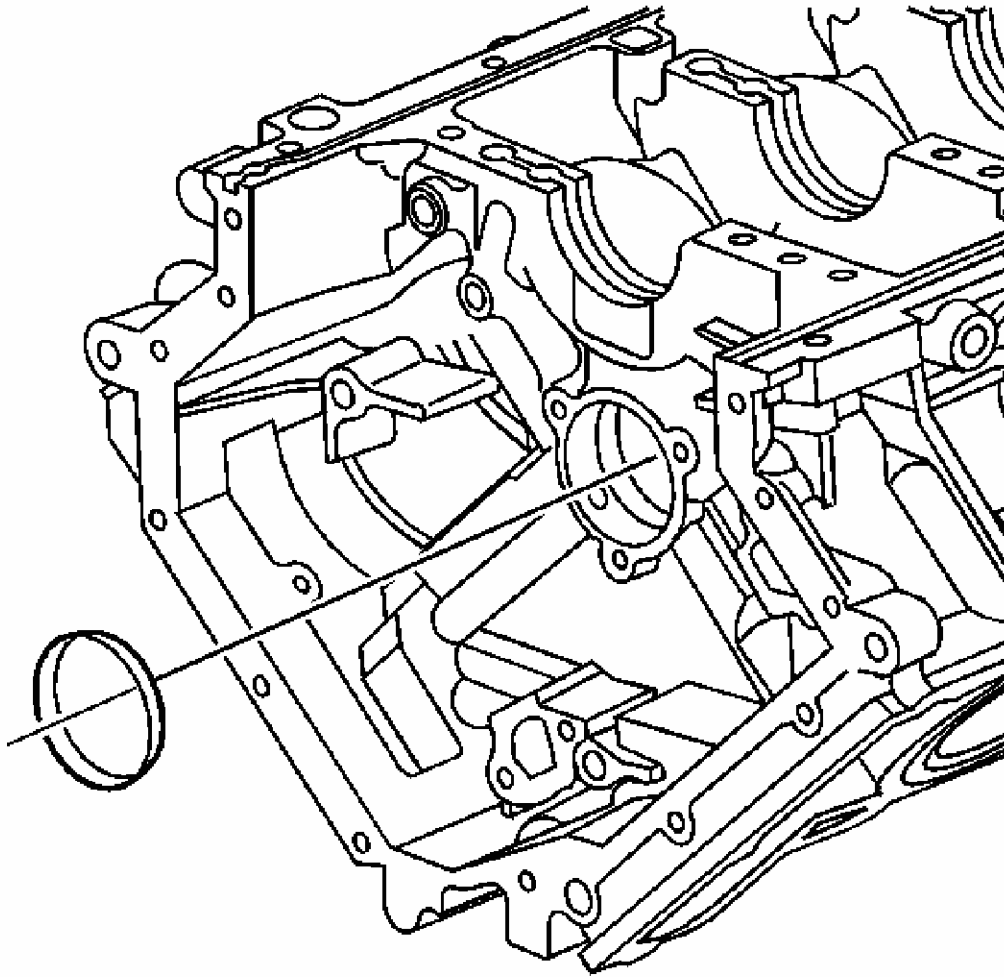


Fig. 337: View Of Camshaft Intermediate Shaft Plug
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft intermediate shaft plug.

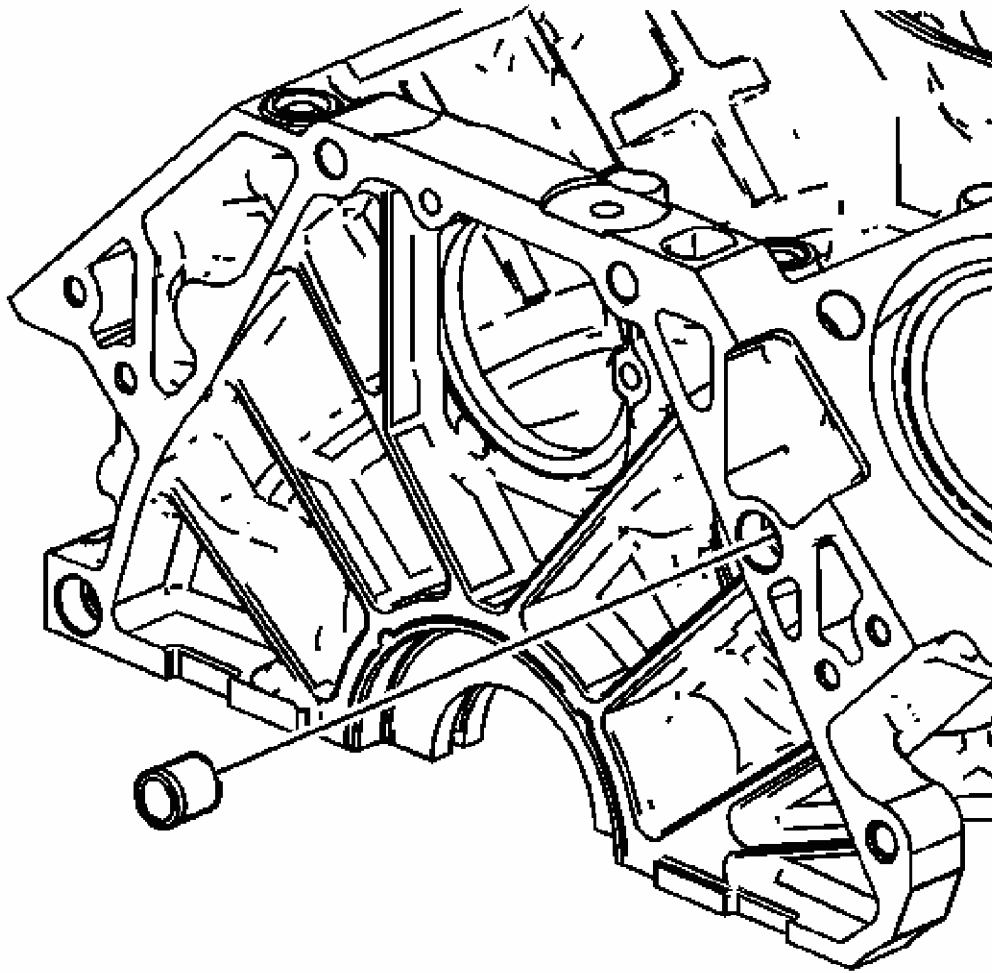


Fig. 338: View Of Transaxle Locating Dowels
Courtesy of GENERAL MOTORS CORP.

4. Remove the transaxle locating dowels.

ENGINE BLOCK CLEANING AND INSPECTION - UPPER

TOOLS REQUIRED

J 8087 Cylinder Bore Gage

CLEANING PROCEDURE

1. Remove any old thread sealant and gasket material or sealant.

2. Clean all the following areas with solvent:
 - Sealing surfaces
 - Cooling passages
 - Oil passages
 - Bearing journals
3. Clean all threaded and through holes with solvent.
4. Prior to the application of RTV sealant GM P/N 12378521 (Canadian P/N 88901148) or equivalent to the engine block seal groove clean the groove and mating surfaces of the upper engine block and the mating surface of the lower crankcase with cleaner solvent GM P/N 12378392 or 12346139 (Canadian P/N 88901247).

CAUTION: Refer to SAFETY GLASSES CAUTION .

5. Dry the upper engine block with compressed air.

VISUAL INSPECTION

1. Inspect the crankshaft bearing journals for damage or spun bearings. The crankshaft bearing journals are not repairable, if the crankshaft bearing journals are damaged the cylinder block assembly must be replaced.
2. Inspect the crankshaft rear oil seal bore for damage. The crankshaft rear oil seal bore is not repairable, if the crankshaft rear oil seal bore is damaged the cylinder block assembly must be replaced.
3. Inspect all sealing and mating surfaces for damage, repair or replace the cylinder block assembly if necessary.
4. Inspect all threaded and through holes for damage or excessive debris.
5. Inspect all bolts for damage, if damaged replace with new bolts only.
6. Inspect the cylinder walls for cracks or damage. The cylinders sleeves are not serviced separately, if the cylinders are damaged the cylinder block assembly must be replaced.
7. Inspect the upper engine block for cracks. Do not repair any cracks. If cracks are found, the cylinder block assembly must be replaced.
8. Repair any damaged threaded holes. Refer to **Thread Repair Specifications** and **Thread Repair** .

CYLINDER BORE DIAMETER MEASUREMENT PROCEDURE

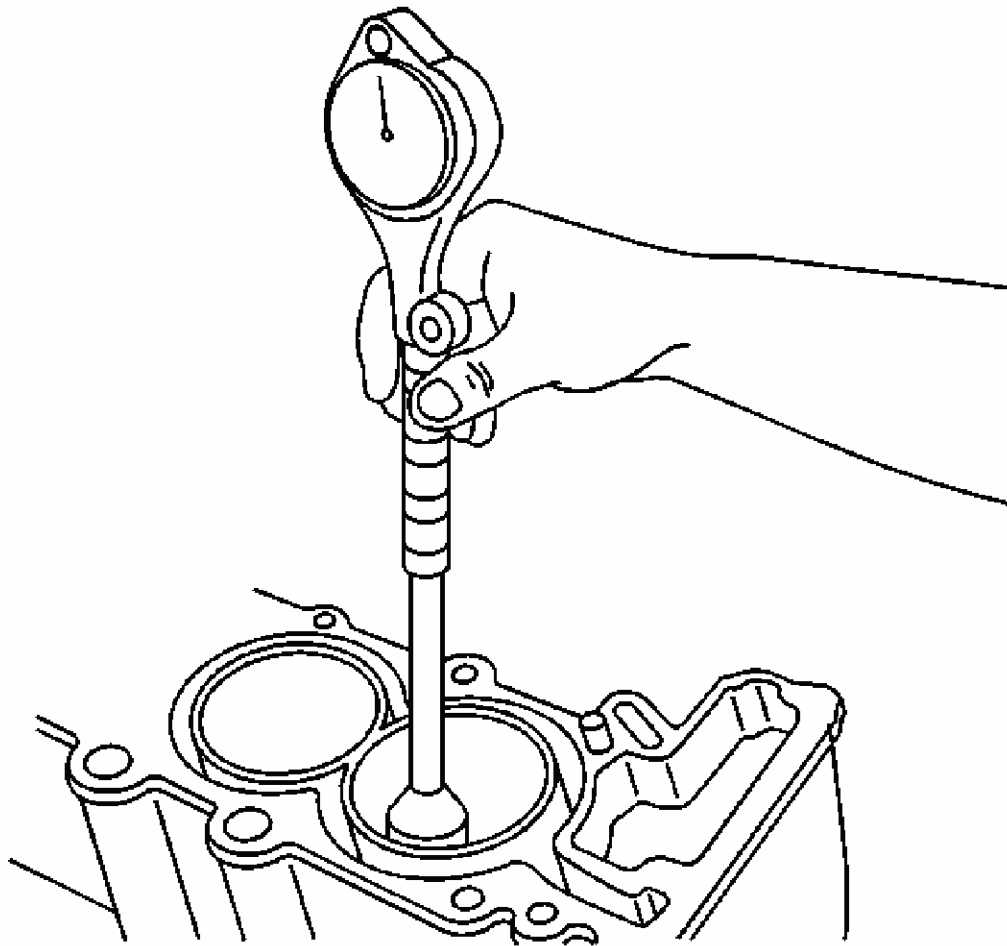


Fig. 339: Measuring Cylinder Bore Diameter
Courtesy of GENERAL MOTORS CORP.

1. Measure the cylinder bore diameter at 41 mm (1.61 in) below the cylinder block deck surface using the **J 8087**.
2. Compare your results with the engine mechanical specifications. If the cylinder diameter exceeds the specifications, the cylinder block must be replaced. There are no oversized pistons available for service.

DECK FACE FLATNESS MEASUREMENT PROCEDURE

1. Place a straight edge across the deck face of the cylinder block at an angle starting at the front of the block and sloping downward to the rear of the block.
2. Measure the gap between the straight edge and cylinder block by sliding the feeler gages under the straight edge at the front, center and rear of the block. Insert the greatest

thickness gage that will fit.

3. Find the difference between the largest and smallest measurement.
4. Change the position of the straight edge so that the angle travels up from the front of the block to the rear.
5. Measure the gap between the straight edge and the deck face again at the front, center and rear. Insert the greatest thickness gage that will fit.
6. Find the difference between the largest and smallest measurement.
7. Position the straight edge so it travels through the center of the cylinder bores.
8. Measure the gap between the straight edge and the deck face a final time at the front, center and rear. Insert the greatest thickness gage that will fit.
9. Find the difference between the largest and smallest measurement.

IMPORTANT: If the flatness measurement exceeds the specifications, replace the cylinder block. Machining of the deck face surface is NOT allowed.

10. Compare your measurement to the engine mechanical specifications.

CYLINDER BORE TAPER MEASUREMENT PROCEDURE

1. Measure the cylinder bore along the thrust surfaces at 5 mm (0.200 in) below the deck surface with the bore gage perpendicular to the crankshaft centerline and record the measurements.
2. Measure the cylinder bore along the thrust surfaces at 102 mm (4.000 in) below the deck surface with the bore gage perpendicular to the crankshaft centerline and record the measurements.
3. Calculate the difference between the two measurements. The result will be the cylinder taper.
4. Compare your results with the engine mechanical specifications. If the cylinders exceed these specifications, replace the cylinder block.

CYLINDER BORE OUT-OF-ROUND MEASUREMENT PROCEDURE

1. Measure both the thrust and non-thrust cylinder diameter 5 mm (0.20 in) below the deck surface using the **J 8087** . Record your measurements.
2. Calculate the difference between the two measurements. The result will indicate out-of-round at the upper end of the cylinder.
3. Measure both the thrust and non-thrust cylinder diameter 102 mm (4.00 in) below the deck surface using the **J 8087** . Record your measurements.
4. Calculate the difference between the two measurements. The result will indicate out-of-round at the lower end of the cylinder.

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5. Compare your results with the engine mechanical specifications. If the cylinders exceed these specifications, replace the cylinder block.

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